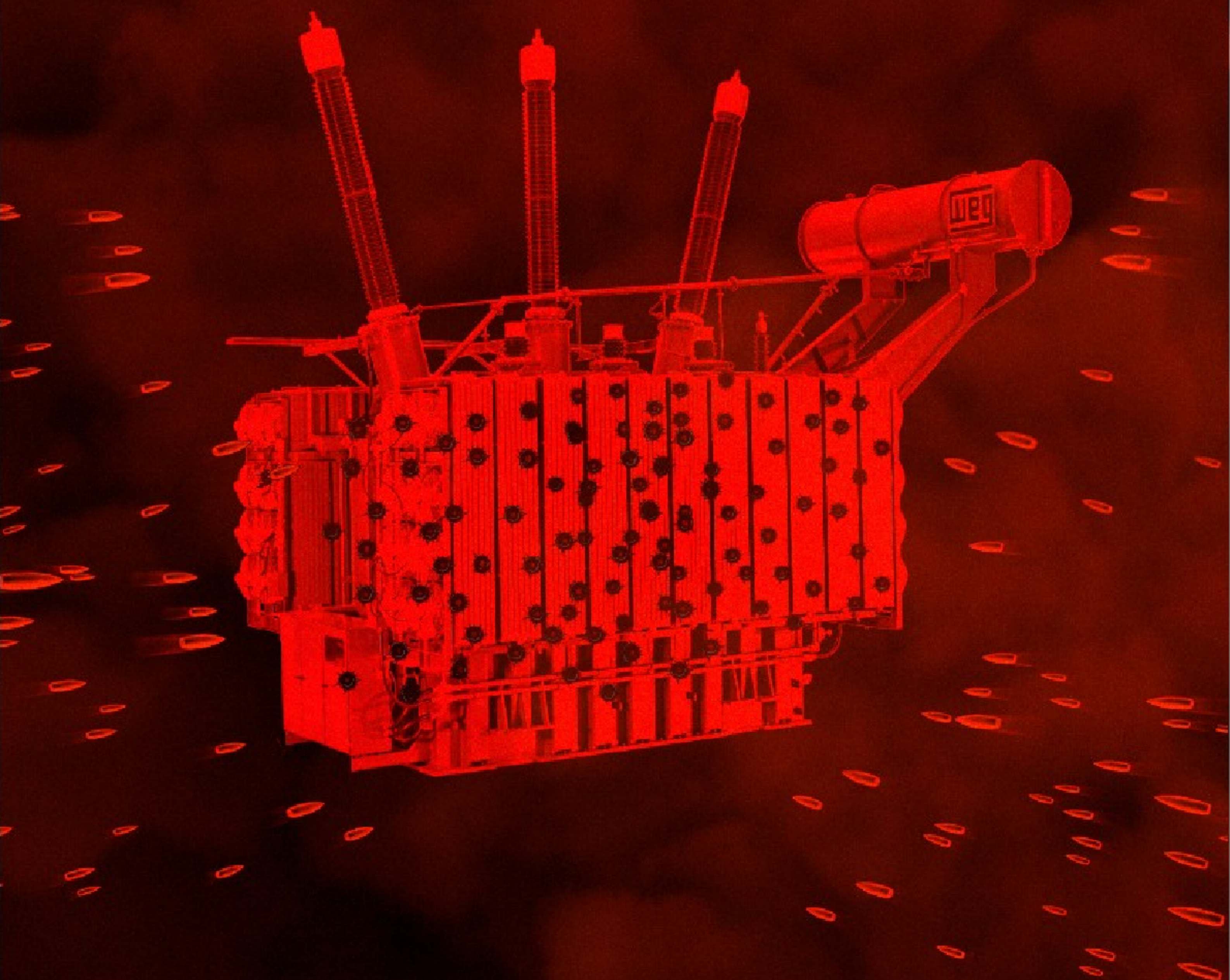


REDSTONE KILLERS



Δ° ❁ l a s e r h a w k ❁

Metcalf sniper attack

Article Talk

On April 16, 2013, an attack was carried out on [Pacific Gas and Electric Company's Metcalf transmission substation](#) in [Coyote, California](#), near the border of [San Jose](#). The attack, in which gunmen fired on 17 electrical [transformers](#), resulted in more than \$15 million worth of equipment damage, but it had little impact on the station's electrical power supply.^{[1][2][3]}

Metcalf sniper attack	
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CCTV footage (Attacks happen at around 2:07)	
Location	Coyote, California , U.S.
Date	April 16, 2013 12:58 – 1:50 a.m. (PDT)
Target	PG&E Metcalf substation
Attack type	Sabotage
Weapons	7.62×39mm rifles

^ Assault

On the morning of April 16, 2013, a team of gunmen, using rifles, opened fire on the Metcalf Transmission Substation, severely damaging 17 [transformers](#).^{[4][5][6]}

Preparation

Prior to the attack, a series of [fiber-optic telecommunications cables](#) operated by [AT&T](#) were cut by the culprits. Additionally, following the attack, investigators found small piles of rocks

near to where the shots had been fired, the type of formations that can be used to scout firing positions.^{[7][8]}

Timeline



- 12:58 a.m. – AT&T fiber-optic telecommunications cables were cut not far from [U.S. Route 101](#) just outside south San Jose.
- 1:07 a.m. – Some customers of [Level 3 Communications](#), an Internet service provider, lost service. Cables in its vault near the Metcalf substation were also cut.
- 1:31 a.m. – A surveillance camera pointed along a chain-link fence around the substation recorded a streak of light that investigators from the Santa Clara County Sheriff's office think was a signal from a waved flashlight. It was followed by the muzzle flash of rifles and sparks from bullets hitting the fence.
- 1:37 a.m. – PG&E received an alarm from motion sensors at the substation, possibly from bullets grazing the fence.
- 1:41 a.m. – Santa Clara County Sheriff's department received a 911 call about gunfire, sent by an engineer at a nearby power plant that still had phone service.
- 1:45 a.m. – The first bank of transformers, riddled with bullet holes and having leaked 52,000 US gallons (200,000 l; 43,000 imp gal) of oil, overheated, whereupon PG&E's control center about 90 miles (140 km) north received an equipment-failure alarm.
- 1:50 a.m. – Another apparent flashlight signal, caught on film, marked the end of the attack. More than 100 expended [7.62×39mm](#) cases were later found at the site.
- 1:51 a.m. – Law-enforcement officers arrived, but found everything quiet. Unable to get past the locked fence and seeing nothing suspicious, they left.
- 3:15 a.m. – A PG&E worker arrived to survey the damage.^[7]

Sophistication of attack



Former Chairman of the Federal Energy Regulatory Commission [Jon Wellinghoff](#) stated that military experts informed him that the assault looked like a "professional job", noting that no fingerprints were discovered on the empty casings.^[7] While Wellinghoff described the attack as "the most significant incident of domestic terrorism involving the grid that has ever occurred", a spokesman for the [Federal Bureau of Investigation](#) stated that they did not believe a terrorist organization was responsible.^[9]

[Henry Waxman](#), a ranking member of the [United States House Committee on Energy and Commerce](#), stated that the attack was "an unprecedented and sophisticated attack on an

electric grid substation with military-style weapons. Communications were disrupted. The attack inflicted substantial damage. It took weeks to replace the damaged parts. Under slightly different conditions, there could have been serious power outages or worse."^[8]

^ Aftermath



Seventeen transformers were seriously damaged, requiring over \$15 million worth of repairs. To avert a black-out, energy grid officials had to reroute power from nearby [Silicon Valley](#)-based power plants.^{[2][10]} While some nearby neighborhoods temporarily lost power, "the big users weren't even aware Metcalf had happened", according to an expert from the [Electric Power Research Institute](#).^[1]

Both PG&E, the company which operated the transformers, and AT&T offered \$250,000 rewards for any information leading to the arrest and conviction of the perpetrators of the attack.^{[6][11]}

In June 2014, PG&E announced that it intended to spend \$100 million over a three-year span on upgrading security at substations throughout its territory, including the Metcalf location.^[12]

A July 2014 report from the [Congressional Research Service](#) titled *Physical Security of the U.S. Power Grid: High-Voltage Transformer Substations* repeatedly cited the attack and noted that, "... in the wake of the Metcalf incident, the [FERC](#) has ordered the imposition of mandatory [physical security](#) standards (for substations) in 2014."^{[13][14]}

^ Investigation



In October 2015, it was reported that the [Department of Homeland Security](#) had found indications that the attack may have been committed by "an insider".^[15]

^ Precursor publications



In 2012, the [National Research Council](#) of the [National Academies of Sciences, Engineering, and Medicine](#) published a declassified report prepared in 2007 for the United States Department of Homeland Security that highlighted the vulnerability of the national electric grid from damage to high voltage transformers.^[16]

^ See also



DIVE BRIEF

Sniper attack on Utah substation highlights grid vulnerability

Published Oct. 13, 2016



Robert Walton
Senior Reporter



Depositphotos

Dive Brief:

- Deseret News reported last month that someone with a high-powered rifle fired several shots and successfully disabled a substation owned by Garkane Energy Cooperative, leading to a day-long power outage for about 13,000 Utah residents.
- The co-op offered up to \$50,000 for information leading to a reward; the damage will take months to repair and could cost up to \$1 million.

- The incident, reminiscent of an attack on a Pacific Gas and Electric substation in 2013, is a reminder that large portions of the United States' grid remain vulnerable to attack, potentially from either cyber intrusions or being physically disabled.

Dive Insight:

While much of grid security concern is now focused on the potential for a blackout-inducing cyberattack, the events in Utah are a reminder that physical vulnerabilities are prevalent and a larger blackout is still possible.

Navigant energy director Brian Harrell spoke with EnergyWire about the attack, saying "electric infrastructure continues to be vulnerable to firearms attack ... we must assume that at some point in the future a North American utility will suffer from a planned and coordinated attack against electrical infrastructure."

Three years ago, a PG&E was targeted in a sniper attack that disabled 17 transformers. The utility responded with a \$100 million security spending plan, and federal security protocols have been upgraded. But the span of the grid makes protecting infrastructure difficult.

By contrast, Garkane serves six counties in South-Central Utah and two counties in North-Central Arizona, a largely rural area. The co-op also serves four national parks, and private lands encompass only about 10% of its service territory of 16,000 square miles.

The attack on Garkane succeeded when bullets disabled the transformer's oil-cooled radiator.

Recently, grid security has been focused on cybersecurity. Lloyd's of London last year issued a report finding a widespread attack on the United States grid could lead to a total economic loss ranging from \$243 billion up to \$1 trillion in the most damaging scenarios. A series of cyberattacks in Ukraine caused widespread blackouts, underscoring the worries from utility officials and

Thousands of Colorado residents without heat after attack on gas service

The temperature in Aspen, Colorado, will fall to 2 degrees Tuesday night.

By [Bill Hutchinson](#)

December 29, 2020, 5:41 PM

The FBI has joined a criminal investigation of what police said appears to be an "intentional attack" on gas service lines in Aspen.

Work crews are scrambling to restore gas service, and local authorities handed out electric space heaters to residents still without heat.

Aspen police said the apparently coordinated acts of vandalism occurred Saturday night at three separate Black Hills Energy gas service lines.

At one of the targeted sites, police said they found the words "Earth first" scrawled, and investigators were looking into whether it was linked to the group.

Emails from ABC News to the group's website seeking comment were not returned.



In this Dec. 1, 2014, file photo, Aspen, Colo., is shown.

John Locher/AP, FILE

Aspen Assistant Police Chief Bill Linn told reporters that the saboteurs appeared to "have some familiarity" with the natural gas system.

"They tampered with flow lines. They turned off gas lines," Linn said.

MORE: Domestic terrorism and hate exploded in 2020. Here's what the Biden administration is doing about it.

Linn said physical evidence recovered at the scenes of the vandalism included footprints left in the snow. He said there were no signs of a vehicle or any weapons.

MORE: Nation's deadliest domestic terrorist inspiring new generation of hate-filled extremists.

The FBI, which has a critical infrastructure protection unit, is helping in the investigation, Linn said.

Black Hills Energy officials said about 3,500 customers were affected by the gas outage, and crews had to go to each natural gas r

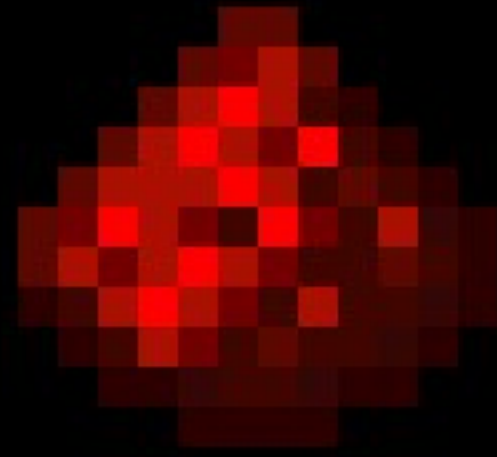
MORE: Would-be eco-terrorist plotted to blow up pipeline, communicated with C

Linn said the police department was handing out about 6,000 portable space heaters to residents.

He added that numerous businesses, including restaurants and hotels, had to shut down due to the loss of gas.

"It's almost, to me, an act of terrorism," Pitkin County Commissioner Patti Clapper, who lost heat in her home due to the vandali

Do you see this nigger here?



In the struggle against the federal glowNIGGERS who NIG and the eternal khazar semitic swindler rat-faced jew hooknosed hebrew kike freak untermenschen, the redstone is your greatest enemy.

The redstone gives the glowniggers ears and eyes to spy on you.

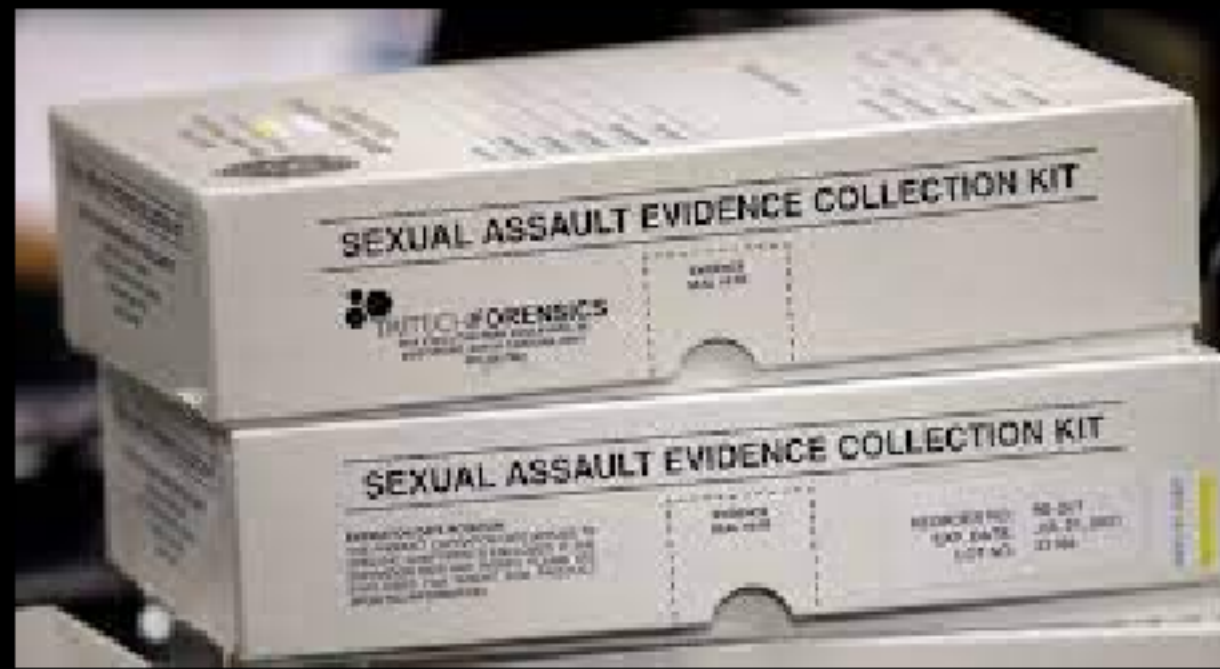
Any machination powered by redstone is regulated so as to appease the eternal subhuman swinder bastardization of a race known as the infernal jew.



Cameras? Redstone.



IMSI Catcher? Redstone.



Rape kits? Redstone.



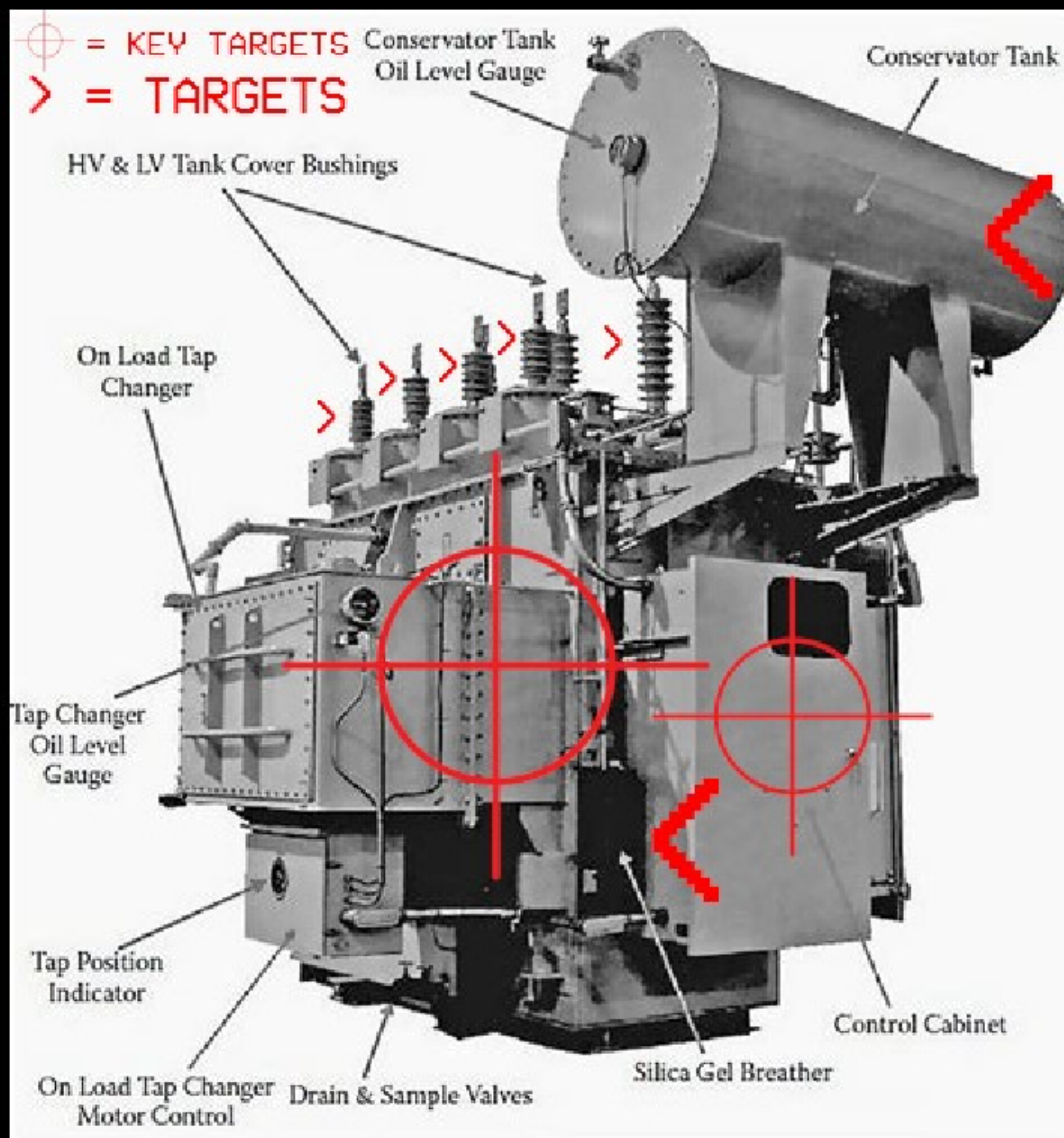
Home alarms? Redstone.



Brasstrax? Redstone.



Bullettrax? Redstone.



WHAT ARE THE KEY POINTS TO HIT ON A TRANSFORMER IN AN ELECTRICAL SUBSTATION:

- CERAMIC BUSHINGS/INSULATORS
- THE CENTER MASS OF THE TRANSFORMER, WHERE THE CORE IS HOUSED
- THE OIL CONSERVATOR TANK
- THE SILICA GEL BREATHERS
- THE CONTROL CABINET

YOU SHOULD DO THE FOLLOWING:

1. SHOOT THE BUSHINGS OF EACH TRANSFORMER AND CAUSE THEM TO EXPLODE.
2. PUT TWO SHOTS IN THE OIL TANK TO DRAIN THE TANK.
3. PUT ONE OR TWO BULLETS INTO THE CONTROL CABINET.
4. PUT NOTHING SHORT OF TEN ROUNDS INTO THE CORE TO INDUCE A SHORT CIRCUIT. BASICALLY, THE CENTER MASS OF THE TRANSFORMER.
5. PUT A COUPLE ROUNDS INTO THE SILICA GEL BREATHER.
6. IF CREW IS ON SITE, TRY TO AVOID KILLING THEM BUT IF YOU MUST, TAKE THEM THE FUCK OUT.

The grid is more vulnerable in its transmission system. The FERC "Project Gridstrike" report is correct that hitting just a few key transmission substations would take down the Bulk Electric System in a region (keeping in mind that in mainland US minus Alaska there are 3 separate grids, Western, Eastern, and Texas). That's the thing though, just the Bulk Electric System. In areas that are energy rich, they aren't reliant on the BES, since they have local generation resources. Places like California will probably be pretty majorly impacted, but others not so much.

I also think the bit about transformer manufacturers is a bit over blown, since its almost certainly the case that other types of manufacturing would retool to build the needed transformers as quickly as possible. The huge turn around time in transformer orders isn't due an overload of demand and lack of supply, but a very low demand and little current need for inventory. Transformers do take a while to build, but most utilities order them ahead of when they are needed, so the manufacturers don't keep stock. If a catastrophic event happened like what the report presents, likely several manufacturers would be tapped to build temporary replacements to get the grid on its feet while more permanent replacements are built.

Of course, more local generation, like distributed solar would actually alleviate a lot of these problems, but distributing generation brings its own problems. Conservationists and power marketers might love two way metering by the consumers (both saving power and increased revenue from having more power available to sell), but operations and maintenance staff hate it, as it causes all kinds of safety and reliability problems. If a line goes down in an area where a customer is generating and pushing power back through his meter, there is real risk to the line crews sent to repair the line if the customer didn't open his breaker. There are other problems with two way metering, but that is probably the biggest.

The FERC report isn't really earth shattering, the power industry has known about this for years. This is something that every developed nation is at risk of. It's also not something you can just fix. It is a fundamental vulnerability in the accepted model of power generation, transmission and distribution, and with some areas being power scarce, we have to transmit power somehow, and the only way to do it efficiently, both monetarily and from a power efficiency stand point) is over a few lines at high voltages.

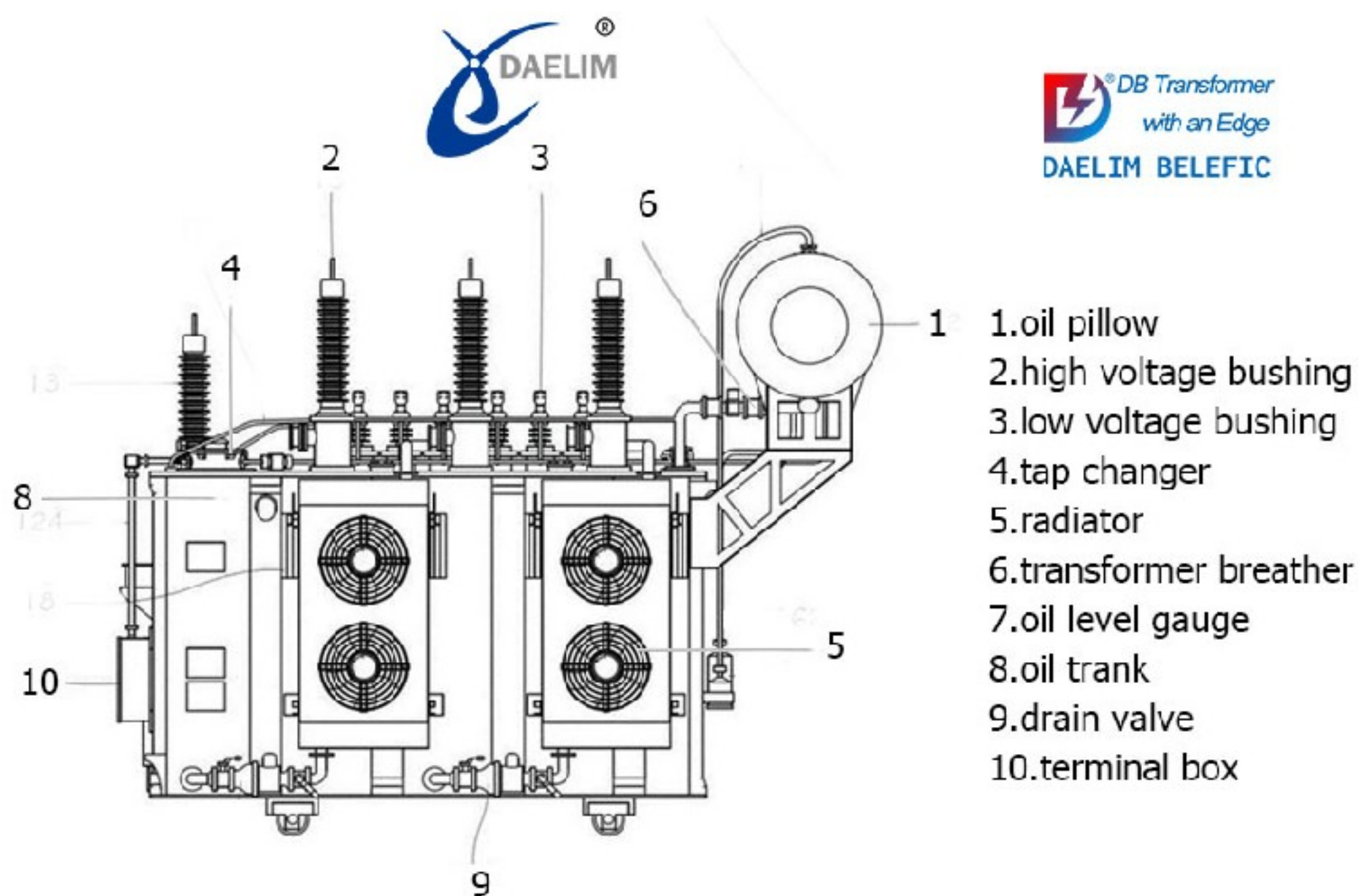
There are protections built into a transformer to help protect it from loss of coolant. This is precisely why you should shoot the control circuit and try to drain the fucking conservator tank of every single drop of oil, as well as shooting center mass into the core and popping all the ceramic bushings the fuck off, causing them to rupture and explode.



What is the structure of the oil immersed transformer?

02 Jun

What is the structure of the oil immersed transformer?



Oil-immersed transformers have the characteristics of good heat dissipation, low loss, large capacity, and high efficiency. In power transformers running in the power grid are oil-immersed transformers. This article focuses on an oil-immersed transformer.

The iron core and winding constitute the important parts of the three-phase oil-immersed transformer. Other parts include conservators, bushings, breathing apparatus, radiators, tap changers, gas relays, thermometers, oil purifiers, and so on.



4. [Oil conservator](#)
5. [Transformer bushing](#)
 - [Transformer bushing types](#)
 - [Insulating bushing](#)
6. [Transformer breather](#)
 - [What is a transformer breather?](#)
 - [Why breather used in transformer?](#)
7. [Pressure release device](#)
8. [Transformer Radiator](#)
9. [Buchholz gas relay](#)
10. [Tap changer](#)
 - [What is tap changer?](#)
 - [What are the types of tap changers?](#)
 - [Where is the tap changer in the transformer?](#)
12. [Oil purifier](#)
13. [Daelim Transformer Manufacturer](#)

Iron core

What does the iron core do in a transformer?

The iron core is the main magnetic circuit of the transformer, and its main function is to conduct magnetism from the primary circuit into magnetic energy, and from the magnetic energy into the electrical energy of the secondary circuit.

The iron core in the transformer is generally made of silicon steel sheets stacked, and the silicon steel sheet mainly affects the no-load loss of the transformer.

According to the arrangement of the windings in the iron core: there are two types of iron core type and iron core column, the high and low voltage windings, and the iron yoke constitute the closed magnetic circuit.

Daelim's iron core is made of cold-rolled oriented silicon steel sheet, with 80, 85, 90, 100, and 110 grades of silicon steel. The lower the grade, the lower the no-load loss, the better the transformer performance, and the iron core structure. The iron core of the large-capacity transformer to achieve a good cooling effect.

Transformer Winding



The windings constitute the circuit of the transformer. There are two types: primary windings and secondary windings.



biodegradable, etc., but its price is high, 3-4 times that of mineral oil.

You can choose the transformer oil that suits your needs.

Learn more now: [What is the difference between mineral oil, Vegetable oil, and](#)

3. What is transformer oil used for?

Transformer oil is insulating. The insulation performance of transformer oil is better than that of air. Immediate insulation performance everywhere, and avoid contact with air to prevent windings from getting wet;

On the other hand, it is the heat dissipation effect, which uses the convection of the oil to dissipate the heat from the winding to the outside through the transformer tank wall and the heat dissipation pipe.

Oil conservator (oil pillow)

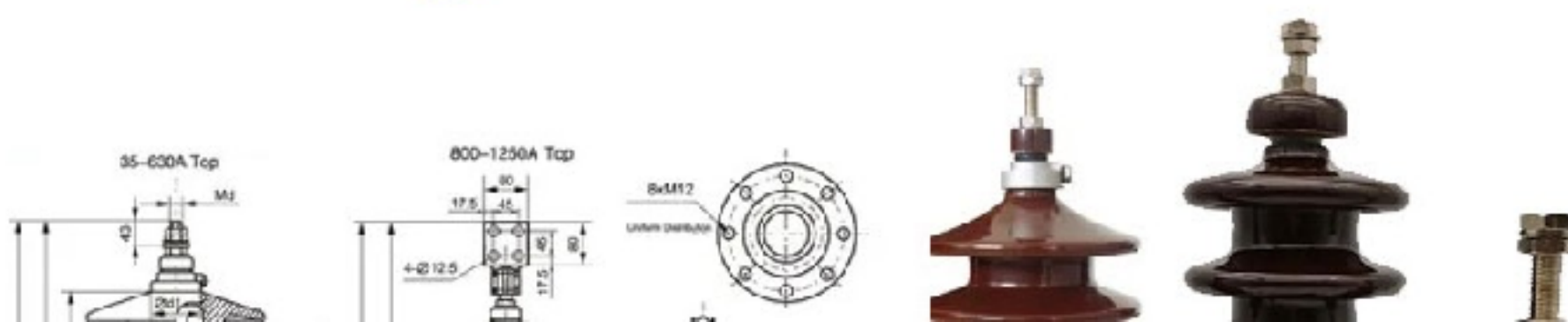
The transformer oil conservator looks like a cylindrical pillow, so it is also called oil pillow. It is placed horizontally and connected to the oil tank of the transformer with a pipeline. The volume of the oil conservator is generally 1/10 of the oil tank.

The oil conservators provided by Daelim are Corrugated type, Capsule type, and Diaphragm type. Among them, the Diaphragm type will be more expensive, and you can choose according to your needs.

When the transformer oil is heated and expanded, transformer oil flows into the oil conservator from the oil tank. When the oil contracts when cold, the transformer oil is replenished from the oil conservator to the oil tank. The oil conservator ensures that when the volume of transformer oil expands or shrinks with the change of oil temperature, the oil tank is replenished to ensure that the oil tank is filled with oil so that the iron core and winding are completely immersed in oil. Transformer oil is only in contact with the air in the oil pillow, which can reduce the contact area between the oil and the air, reduce the chance of the transformer oil being damp and oxidized.

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Transformer Bushing





connection between the flange and the conductive rod.

Transformer bushing oil leakage is the most common fault. The reason for the oil leakage of the bushing is on the upper part of the bushing and the rubber flat gasket at the bottom of the bushing, which requires re the sealing ring and rubber gasket of the bushing.

Transformer breather

1. What is a transformer breather?

The transformer breather, also known as a hygroscopic device, usually consists of a tube and glass container (activated alumina) inside.

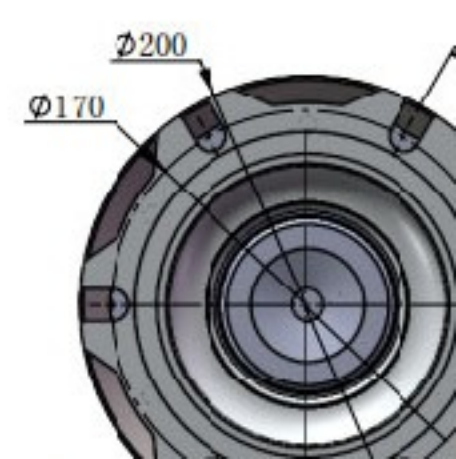
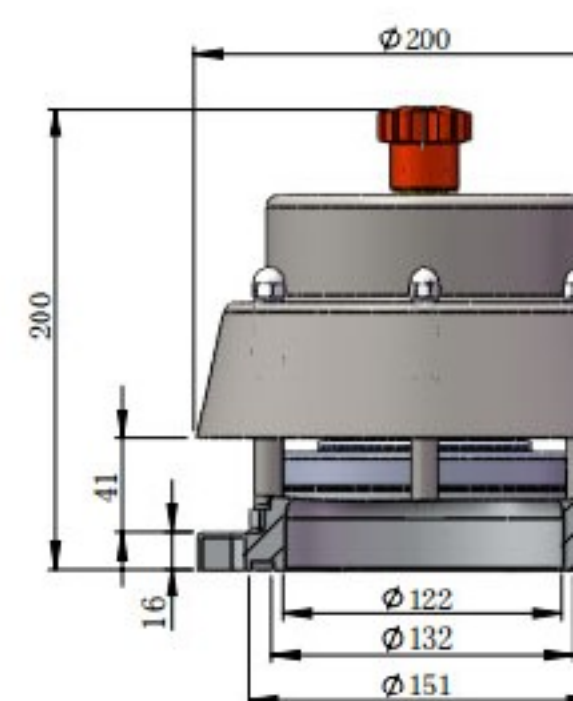
2. Why breather used in transformer?

Clean and dry the sundries and moisture in the air of the oil conservator to maintain the insulation strength

When the air in the oil conservator expands or shrinks with the volume of the transformer oil, the exhaust respirator, and the desiccant in the respirator absorbs the moisture in the air and filters the air to keep the cobalt chloride, its particles are cobalt blue when dry, but as the silica gel absorbs water and is close to saturation turn into powdery white or red, and it can be judged whether the silica gel has failed. The damp silica gel drying. When the color of the silica gel particles becomes cobalt blue, the regeneration work is completed.

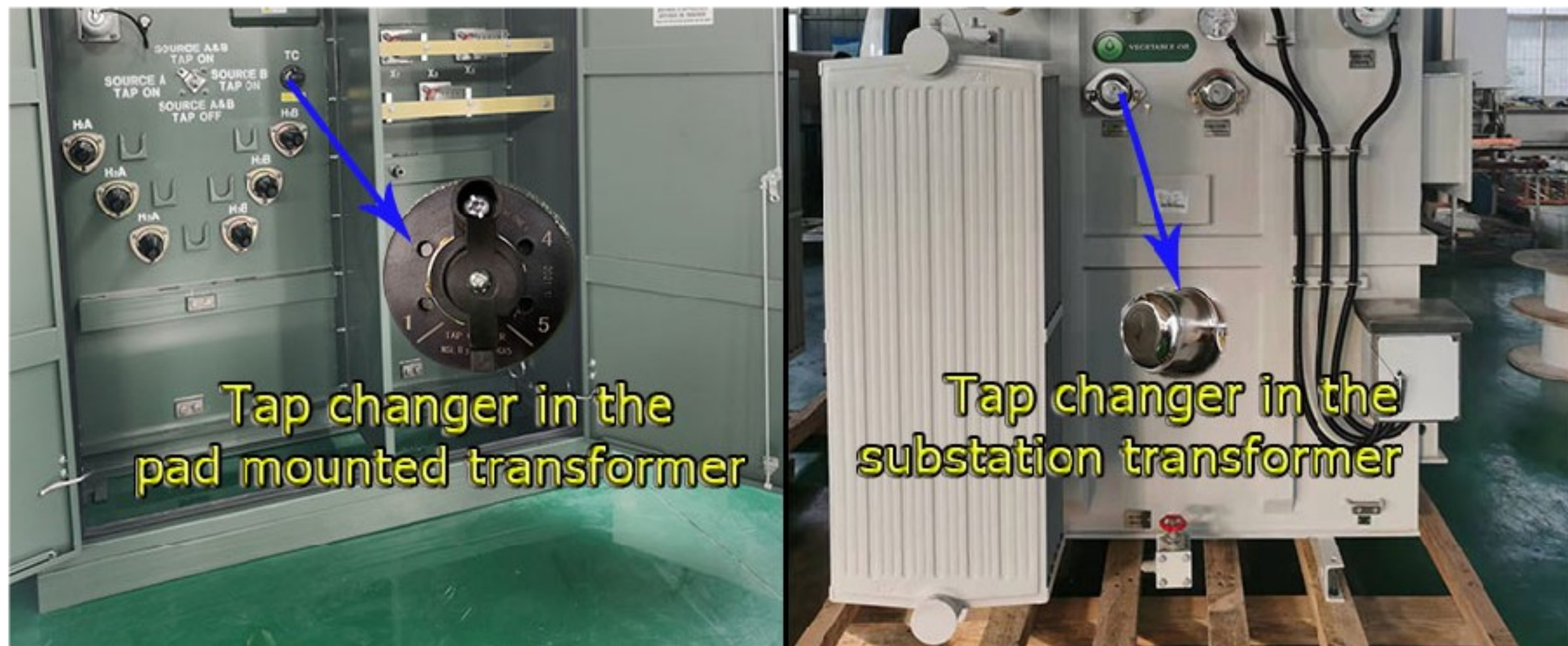
Pressure release device

Pressure relief devices play an important role in protecting power transformers. In oil-immersed transformers, if there is an internal fault or short circuit, arcing will instantly vaporize the oil, resulting in a rapid increase in the pressure in the transformer tank. If this pressure is not released within a short period of time, the oil tank could rupture, potentially causing an explosion and fire, causing even more damage, so measures must be taken to prevent this from happening. There are two types of pressure release devices: explosion-proof pipe and pressure releaser. The explosion-proof pipe is used for small transformers, and the pressure releaser is used for large and medium-sized transformers.



Transformer Radiator

The form of the transformer radiator is corrugated, fan-shaped, circular, exhaust



1. What is tap changer?

When the oil conservator is used for the on-load voltage regulating transformer, a switch oil conservator is located at the bottom of the oil conservator.

2. What are the types of tap changers?

Transformer voltage regulation methods are divided into two types: on-load voltage regulation and no-load voltage regulation.

On-load voltage regulation(on-load tap changer) means that the transformer can adjust its tap position without stopping the transformer transformation ratio to achieve the purpose of voltage regulation.

The no-load tap changer is a zero-current transfer switch without arc extinguishing measures, and the transformer stops running.

3. Where is the tap changer in transformer?

Transformer taps are generally tapped from the high-voltage side, which mainly considers:

- (1) The high-voltage winding of the transformer is generally on the outside, and the tap is easy to connect;
- (2) The current on the high-voltage side is smaller, the conductor cross-section of the lead wire and the current is smaller, and the influence of poor contact can be easily solved.

In principle, the tap changer can be on either side, and economic and technical comparisons are required. For example, a 500kV large step-down transformer is drawn from the 220kV side, while the 500kV side is fixed.

When the voltage is too low or too high, and it is necessary to adjust several taps of the on-load tap-changer, it is necessary to pay attention to the situation:

It should be adjusted one gear at a time, that is, every time the N+1 or N-1 button is pressed, it will pause for 10 seconds.



Daelim's transformers have good mechanical properties and high electrical properties, and their design complies with international standards IEEE/IEC/CSA/DOE/AS and so on. Daelim's transformer accessories can either come from or be compatible with foreign well-known brands such as ABB/Siemens/Schneider/[Qualitrol](#)/MR, etc. The quality of transformer products meets the requirements of customers. The warranty period of Daelim transformers is at least two years and the service life is more than 20 years, depending on your requirements.

Daelim has a team of highly skilled engineers and a rich experienced marketing team in overseas markets, which has helped many international clients get power projects. At the same time, it also helps dealers and agents to develop the business philosophy is to achieve a win-win and long-term cooperative relationship with customers. If you are a transformer supplier, Daelim will be your best choice.

Learn more now: [*Daelim's International Project*](#)

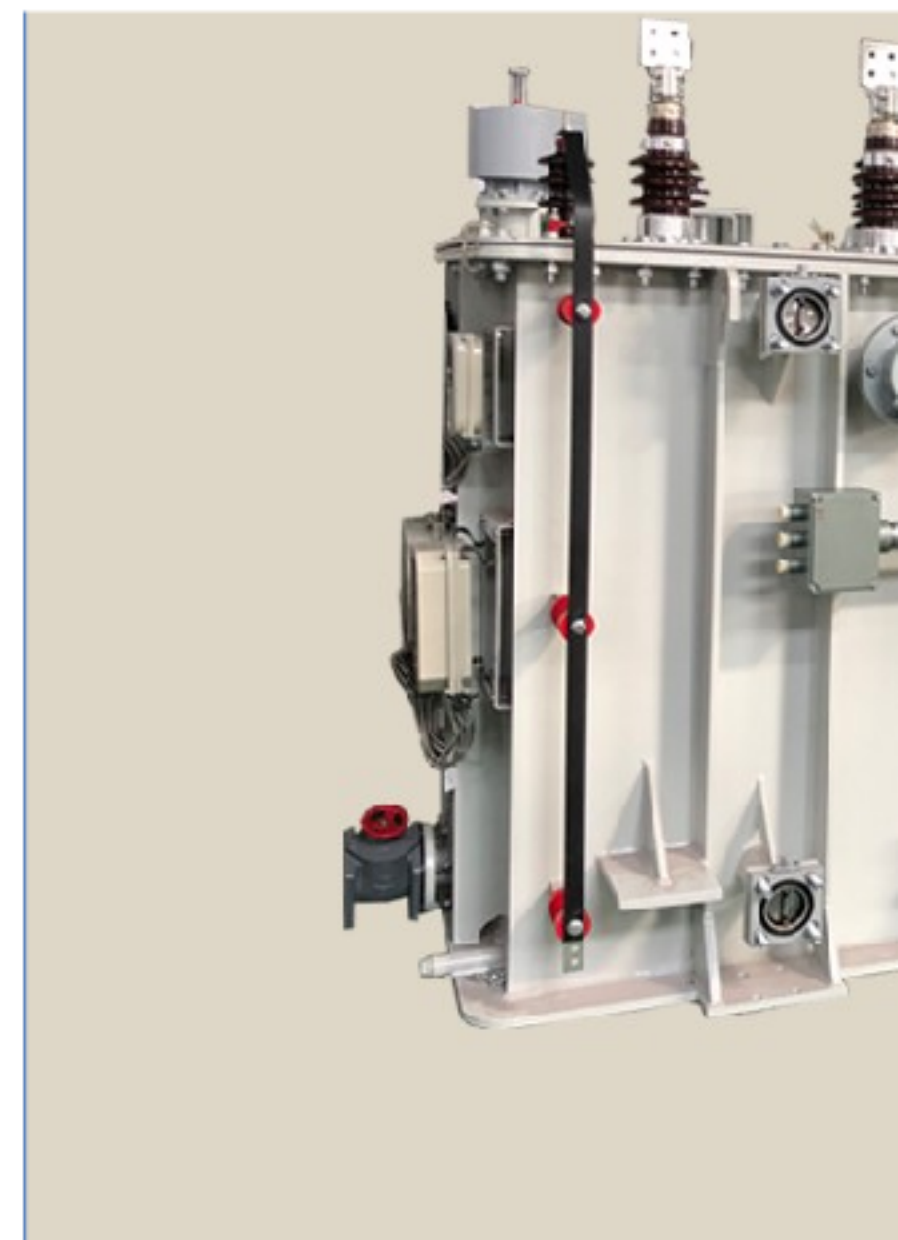
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[What You Need To Know About](#)

The substation transformer is the power substation, and it is highly industry, economy, and our daily substation transformer solution should you know about the sub

The Virgin Shooter

targets meat shields instead
of the system itself

mk-ultra

just wants to be
remembered

played too many video
games, wants high score

never got to join a RWDS



driven by ego

psych meds

false flag

The Chad Saboteur

targets lifeblood of the system

power just went out

anon

could be anyone



driven by conviction

is one of many

inspires similar acts across the
nation

RWDS form in his wake

>>4082231

>the military of the US (not even the drones) would support obama against the american majority

Well, YOU'RE a fucking retard.

I am weeping. Weeping with laughter. Former red team planner for the government here. These are the threads they monitor the most. If there was a revolution in the US, the rest of the world would get involved, fast. Depending on the type of uprising, there is a large chance that it would not be a quick affair. It would be brutal, it would be bloody, and the US government could start a global scale war. Here are the top ten issues that came up.

1. The US power grid can be taken down by a series of "surgical strikes" with the exception of the Texas grid. By surgical strikes, I mean a few marksmen (US army-tier Marksmen—the minimum requirement) hitting certain spots on the grid would fuck a lot of the military and government because they need the grid more than Bubba and his friends do. Additionally, while all government agencies have backup generators, they will be hard pressed dealing with the resultant looting and other madness that would come with power outages. This would effectively create another front for the military. It would also turn the people against the government more quickly and paralyze the government's propaganda machine. Worse still—the key points of the US power grid are publicly obtainable information, and not only are the points too many to be effectively guarded, they are not guarded anyway.

2. The estimated desertion rate in case of a civil war is 75% in the case of a left-wing president. 50% of that would be assumed to immediately betray the president. The remaining (treasonous) military would be fighting its own. Yet another front created in the war. Additionally, there is an assumed 25-50% desertion or outright betrayal rate in three letter government agencies (FBI, CIA, NSA, ATC, TSA, etc.). Additionally, it is assumed that 5% of the initial 50% betrayers would stay in their job and become saboteurs. 10% of that 50% would contain key information that would be of critical danger to the US government. Of that 10%, 1% would be able to deliver that information to the US' foreign enemies. What you should get from this is that the second the United States government declares war on its own is the second it ceases to exist as the state we know it.

3. "Tea baggers," "right-wing extremists," and "oathkeepers" which are considered untrained racists who aren't "good with a gun" often are A) veterans who now have more time to have fun at the range, sometimes more than some Army units or Marine units. In addition to previous military training, B) often camp and do other outdoor activities—more than many in the military do, as the focus has gone away from field exercises, and C) often have better equipment—outside of armor and heavy weapons—than the military. However, C) is kind of irrelevant because many of the places in which these people could hide would make the kind of war the US fights with the equipment they use pointless.

4. Outside influence is a huge problem. Russia has already stated they would back a Texas seperation movement. and right now we already have enough problem keeping Islam in check. The second the US has to fight in a "civil war" is the second it becomes a proxy war between NATO and whoever wants to mess with America. While America has amazing nuclear and air defense, if it comes to a civil war you have to assume that in a best cast scenario the US military is going to be operating at 50% capacity at best. Shit would go down. Hard. And fast. And if Russia—spoiler alert: one of the best militaries in the world at fighting in an urban environment—sent trainers and helpers to rebels, you can reliably bet that they would also possibly deliver weapons to them. So instead of fighting "Timmy TeaBagger," you are fighting "Timmy TeaBagger who is buddies with Vlad."

>>4082276

5. A civil war is not just the US versus the rebels. There will be looting. There will be rioting. Cities will burn. The National Guard cannot fight both the rebels and rioters in a city that would also cut off their supplies. Additionally, if you don't think that the rebels will send in instigators into the cities—or worse, stand alone actors (A Lone Wolf on steroids. Think Timothy McVeigh, but instead of one van they have a whole fleet of them. A good movie example would be Bane)—you would be mistaken. If the US government cannot even help its own people. why would its own people support the remaining (treasonous) military? Worse yet, if someone emptied out prisons (There are more prisoners in the US than there are people in the entire Chinese Army), you would have more crime than the police could ever handle.

6. Logistics and infrastructure in the US are crumbling and failing. Any war fought against a rebellion in the US would be a logistical nightmare, even before the rebels started going full Al-Qaida and putting IEDs in the road. A retired general who was contracting with us on the team said, "The only thing holding together the US' infrastructure is duct tape and the will of the Department of Transportation. And often enough, there isn't enough duct tape." Your most loyal cities to the US government, as we polled, are also the most logistically easy to cut off. NYC? San Fran? L.A.? D.C.? Baltimore? Most of them require crossing water to enter, from certain directions. Most of them have critical air ports. Some of them have critical ocean ports. If anything happened to just TWO of the cities on the list, it would create a logistical clusterfuck.

7. Your "Johnny Reb" and "Timmy TeaBagger" states (i.e., "red" states) all have something most of your "oh so progressive," "Aren't we so European," "Oh my god, we are just like Sweden," blue states don't. Blues are mainly consumer states. Reds are producer states. Urban areas don't have farms. The second that shit goes down, realize a lot of those blue areas are likely to starve. In a civil war scenario, we predicted that at least 10,000 people would die of starvation if the war was not finished in a year. The numbers get worse after that.

8. The US has way too many choke points, and the government forces would often be on the wrong side of them. This ties into the logistical nightmare, but it also has to do with an odd phenomena. Liberals like to live near the ocean. Many of the dividers of the country, like the Rocky Mountains, the Mississippi River, Appalachia, the Missouri River (fun fact: the biggest choke point for the US government is in Missouri) are red state areas. Sure, air travel is a thing, but a majority of the US government's needs would have to travel by ground. Even still, many of the major airports are outside of the city. Of course, the US would use military base air fields, but if civil war did break out... which bases would be safe? Which ones would have fallen to the deserters?

9. PR Nightmare. Every rebel killed on CNN would be spun as "the US government killed X Civilians today in a strike" on foreign news and pirate media not owned by the government. That is—as pointed out earlier—if the US media could even function in a civil war or uprising. Your "rebel scum" know that the main thing that holds together the US—nay life in the US as we know it—is the 24 hour news cycle and the media. The second it's gone, you are going to have urban anarchy. If you are from America, can you imagine a day without TV, newspaper, or Internet? Your average urban youth can't. If you don't think that isn't going to cause rioting, you must have a real high regard for how much restraint they have. Assume in a civil war that your ability to talk to the people is compromised. Also assume that in the case of a civil war that rebels may know how to monitor conversations like the US does, as there are manuals online on how to do so.

10. This one is either 1 or 10, depending on who is asked. The US will never nuke its own. The second it does, they have lost the civil war and other countries will come to "liberate" the US from its own "repressive regime." Additionally, if any general, minuteman, nuke tech, or nuke sub captain decided to side with the rebellion, the US government is immediately SOL.

In short: The second that a "civilian uprising" or "extremist group terrorist attack" turns into "civil war" is the second the US loses. As a result, you will never see a civil war. You will see Waco, you will see Bundy Ranch, you will see all sorts of militant group confrontations and maybe even some skirmishes. But the US government fears its own people way the fuck too much to ever start a civil war.

>>332929663
.....


You're severely overcomplicating things. Let me put this in perspective: the entire US power grid would collapse, coast to coast, for 1-3 years (possibly more) if just 9 of its 30 critical HV transformers were destroyed simultaneously. Operators would need to react within milliseconds to prevent the entire grid from overloading and collapsing which just isn't possible.

There is typically no security at these power stations because according to the suits the risk of an attack is so low it's not worth paying for it. You could waltz in and either nobody or only a couple guys would be there to stop you.

You could make 9 small ANFO/ANNM explosives wired to phones, drop them off at these transformers, call all of them simultaneously and boom, entire fucking grid gone.

This applies to Europe as well because your countries have had a recent emphasis on interconnectivity of their power grids; good because power can be pulled from somewhere else in case of an outage, disastrous because one severe outage in one country will affect all of its neighbors. If severe enough it would collapse its neighbors' power grids as well.

Do what you will with this information. I do not condone terrorism nor especially attacks on power grids, this is an informational post correcting the OP.

 **Anonymous** 08/15/10(Sun)18:02:30 No.264092XXX

[>>264089748](#)

All you need is 8 things:

Potassium Chlorate (at least 90% pure, crystalline)

Vaseline

4 lengths of threaded cast iron pipe 1 foot long, 2 inches in diameter, with a wall thickness of 1/8"

Two pipe caps for each pipe (so 8 in total)

4 empty bottle necked bullet casings with the primers tapped out

Mercury fulminate (percussion pistol primers)

Model rocket ignitors (4)

6 VDC Lantern battery (2 of them)

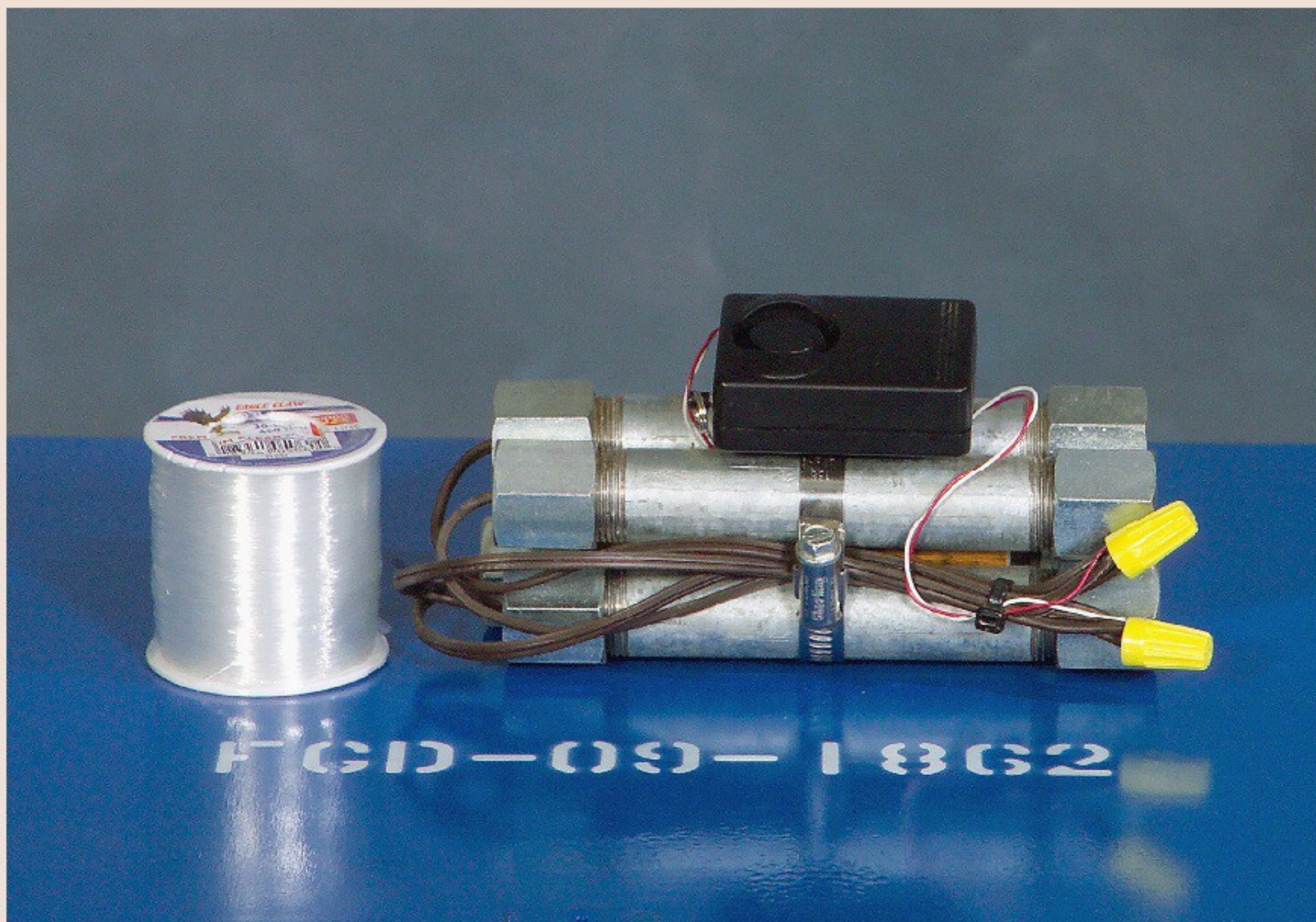
INSTRUCTIONS!!

Powder the chlorate to the consistency of flour. Mix it with vaseline to the formula of 2 9 (2 parts vaseline to 9 parts of potassium) until it becomes a paste. Take the pipes and thread on one cap. Pack the chlorate & vaseline mix 3/4 way up.

To make the detonator: Fill the rifle casings 3/4 with fulminate. Pack in a model rocket ignitor then fill the rest of the way with chlorate mix. Solder extension wires from the ingitors in about 20 foot lengths. Crimp the top of the casing over. Pack it in to the pipe, drill a hole in the last cap, thread out the wires, and twist on the cap.

To Fire: Bring all the wires back from the bundle of pipes and connect half to the positive contacts, half to the negative

Congrats, you just made a cluster bomb.



» **Strelak** 3 days ago ID: 2a3ccb No.212209 [»212210](#)

>>207410

Former cable worker here. I used to be the guy who hunk telephone lines and fiber optic from telephone poles - buried them in the ground, installed power supplies and substations, you name it.

All it would take to completely fuck the communications in an entire city is a normal fathead screwdriver, a pair of wire cutters, and a small fathead screwdriver. Maybe add a pair of bolt cutters to get rid of padlocks.

Fiber optic is the easiest to sabotage: just bend it until you hear it crack and congratulations, you just fucked up a mile and a half of fiber. I'll take them at least a day to figure out what the problem is and where it is, and if you crack the fiber right in the middle of a run they can't just undo an expansion loop and cut off the damaged section. Then they have to order the right fiber (different sizes are used), cut to the right length, and hire a subcontractor to do an emergency job to install the new fiber, which is typically an all day job. Once they're done, a splicer comes in to splice the new fiber into the network. At the very least, if you damage a fiber line, you're looking at two or three days where that line and everyone "downstream" of it has no service, plus tens of thousands of dollars in expense replacing it. Breaking the fiber near the "can" that it goes into (a laser repeater, basically) is easy to fix, they just undo an expansion loop, stretch out the fiber, cut off the damaged section, and splice it. One day of work, max. *Always* break fiber in the middle of a run.

Telephone and cable kinks, too? Just open up the tap, use the small screwdriver to back out the central screw, and close the tap up. With the screws backed out, the cable isn't making contact and no longer signal. They will spend all fucking day trying to figure out what the problem is (note that they'll know exactly *Where* it is) until someone thinks to tighten the screw or just replaces the entire tap. This is nothing serious, but it's something that could be easily and quickly done over and over again to knock out service to a large area.

Power supply cabinets? Use the big screwdriver to open the bicycle lock mechanism (or use a bike lock key, but that doesn't always work), then just unscrewed the battery and unplug the batteries. If you really wanted to be a dick, cut off the padlock, open up the fuse panel, turn the fuse upside down (rightside up is on, upside down is off), close it, and put a new padlock on it. Alternatively, just set off some homemade thermite on top of the cabinet, slightly off center (away from the end with the fuse panel) and it'll fuck up the repeater and both batteries as well as the cabinet itself and they'll have to replace the whole thing, which is an all day job.

And no, most places like major airports, hospitals, military bases, etc. do not have redundant communications lines. They get cable telephone service/internet from a single provider, and that provider runs a single set of lines into whatever place they're servicing.

One man with basic tools could be doing all over a major city and completely fuck its communications, if he knew where to cut off the nodes. Just back out some screws, strip some connections, and you just cut off all communications except for cell phones and radios.

Cell phones you shut down by cutting the fiber optic that goes to the cell tower. Yeah, you didn't know that cell towers had cable and fiber and that's how they connect to the internet and local phone service, did you? You can find the main lines running to the tower and destroy them, or take out the tower itself by shooting the transceivers with a high-powered rifle. Damn, that tower isn't giving a signal anymore.

Continued

» **Strelak** 3 days ago ID: 2a3ccb No.212210

>>212205

Radio is easy to knock out: build a spark gap generator, plug it into a power supply somewhere, and walk away. It's broadband and it'll keep transmitting on every frequency there is and jam the signal within its radius. Set up a bunch of these all over town and nobody is communicating via radio; police, military, fire department, EMS, nobody. I'll jam cell phones too. Yes, they'll triangulate their positions (especially if the military gets involved, this is why you need multiple jammers) and get rid of them, but that takes time, especially the first time it happens when nobody has any idea what the fuck is going on or whose responsibility it is to fix it.

Half a dozen guys can, in a single day, completely fuck over comms in a major city and cause millions of dollars worth of damage and lost revenue with basic tools and spend nothing more than the gas they use driving around. A couple hundred bucks at most if they build a couple dozen spark gap jammers to plant all over town.

People have absolutely no idea how vulnerable our communications infrastructure is. And you know the government's plan for defending said infrastructure?

Hope nobody realizes how vulnerable it is. No, seriously. That's the extent of their plan to prevent massive sabotage: hope people are too stupid to realize how easy it is.

» **Strelak** 3 days ago ID: 2a3ccb No.212217 [»212221](#)

>>207443

Obama doesn't need to shut down the internet entirely, he just needs to block access for common folk. Wall street and major corporations will still get service, you'll get a 502 error.

So much business is done online that shutting down a city's internet for a day would cause millions of dollars of lost revenue, easily. Not to mention cost tens of thousands (possibly hundreds of thousands) of dollars in expenses for the cable providers because they have to pay for replacement cable and fiber, hire contractors to install them (and pay emergency job rates, which are higher than the standard rate), pay their own employees massive overtime (they're all union) to splice everything in once the contractors replace the cable, fiber, etc.

You could very easily fuck up the local economy to the tune of tens of millions of dollars in a single day. Do it to a city like New York and you're getting into the billions.

And while you're shutting down communications, why not shut down transportation too? Use a burner phone and call in bomb threats for major bridges, highway overpasses, etc. They shut down the roads, cops scramble to search for bombs, traffic jams from people being detoured from major roads cause hours of gridlock (especially if you call in the threats at rush hour), etc. and the gridlock makes it harder for police and firefighters to get where they need to go, especially once comms start getting fucked up.

Wanna shut down the airport? Call in a bomb threat there too; they'll ground the planes for hours. Hire an improvised mortar onto the tarmac/runway; you don't need live rounds, just smoke bombs or even duds filled with sand; they have to treat every single one like a live bomb and the airport is completely shut down, no planes in, no planes out, until the bomb squad handles every single mortar round laying on the tarmac. And if the bomb squad is stuck in gridlock because they were across town investigating a bomb threat at an overpass and nobody can get hold of them because phone and radio service is fucked up, you just shut down the airport for the rest of the day.

Half a dozen guys, tops, could fuck over an entire city to the tune of hundreds of millions or even billions of dollars, without hurting a single person or causing any permanent damage.

And there's absolutely no plan in place to deal with this, other than burying our heads in the sand and hoping nobody actually does it. The vulnerability of our infrastructure and the shittiness of its security is inexcusable. We **REALLY** need to be building some redundancy into the system, upgrading our infrastructure and working out an actual plan for defending it, or else the Russians, Chinese, or the Wolverines are going to fuck everybody's shit up with near impunity.

Find out why
most movements will never work!

LEMMINGS

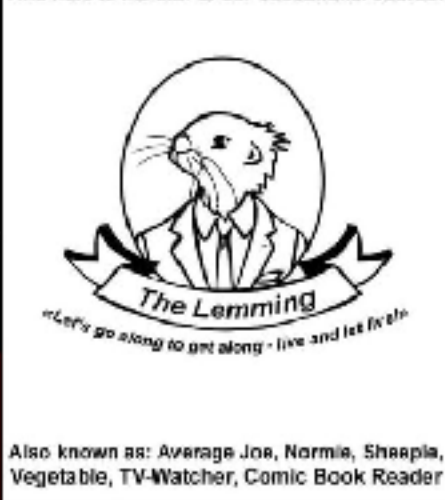
FOR
ALTRIGHT IDIOTS



Lemmings have basic desires of security and happiness. The Lemming will be loyal to whoever provides him with these basic wants.



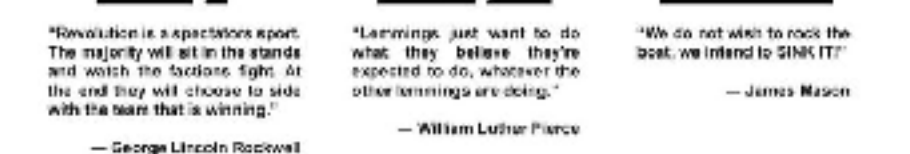
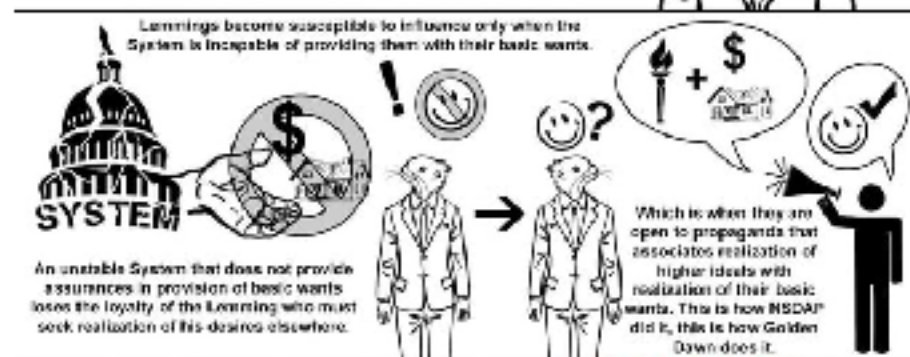
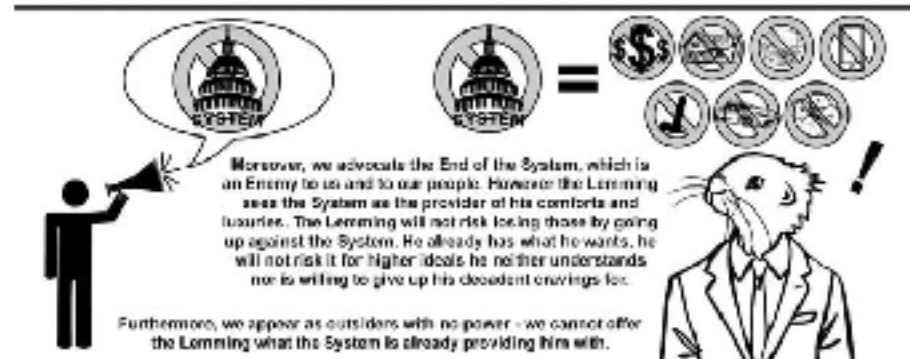
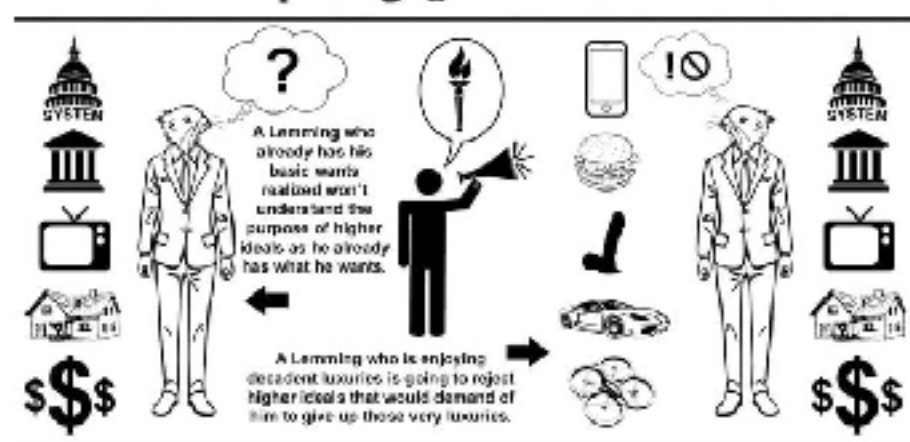
Welcome to Psychology of the Lemming.
And here is the star of our educational course:



The System also holds control over the lemmings through the media and various institutions, including educational.



The Lemming then applies peer pressure to other Lemmings to conform with the System. If's Laws and Standards. Should the Lemming fail to conform, he may be punished and lose his comforts and wants that the System provides.





♥ ■ WHAT ARE THE POLITICAL IMPLICATIONS OF Anonymous (ID: X9jbnTEd) 10/04/22(Tue)09:37:27 No.398280116 >>398280167 (You) >>398280585 >>398281331

ORGANICALLY FORMED, INFILTRATION PROOF CELLS OF ACTIVISTS?

No less than 2, no more than 5

Only people you have known your whole life.

Once your cell is formed, never any new members (tell them to go form their own)

No cell phones when meeting or working (put them in a microwave "faraday cage" at home before you leave, don't bring them to your meeting spot and leave it in your car like a moron) comms, if necessary can be achieved via cheap Baofeng radios if necessary, but you must destroy them after a major op.

3 levels of ops:

White: Legal (Flyers, banners, propaganda) Begin here with your team. Get practice doing things requiring coordination on a timetable. 5 people can flyer and propagandize a large area in a short period of time. *Buy a second hand printer for cash as many systems print a tracking code on each page that can be traced back to you. Wear gloves and face masks. You can dry Elmer's glue on your fingers to provide a degree of fingerprint obfuscation if wearing gloves would cause concern. You must take public transportation for the final leg of your journey to your OP area. Do not drive your POV or even a rental. Electric bikes work well because they can get you out of an area quickly with sustained speeds of 30mph thru parks, alleys etc and their purchase is not traceable.

Gray: Misdemeanor (defacing property, blocking traffic). Think Fight Club Project Mayhem with a focus on defacing/destroying WOKE propaganda. Each mission should have a singular focus, timetable and you must spend hours planning for contingencies, escape routes and alibies if caught. No one talks, everyone walks. Gray ops should only be initiated after your cell has 10+ White ops under it's belt. Mask up always (and your carrying a white and a black mask right?).

Anonymous (ID: X9jbnTEd) 10/04/22(Tue)09:38:00 No.398280167 >>398280116 (You) (OP)
1641384110895.jpg (127 KB, 1024x768) [google](#) [yandex](#) [iqdb](#) [wait](#)



Black: Felony (burning govt. property, killing politicians, media etc.) This type of OP requires the most planning and commitment. Your cell should not attempt this if you do not have several successful Gray operations under your belts. Burning a political building down is easier than killing a politician or msm member, but both land you in 5 star GTA territory. Fire is a great tool, so start with destruction of property before moving on to mincrafting a public figure. Taking out a public figure requires some well honed skillsets. Ability to acquire a ghost firearm and be accurate under stress, impeccable timing and communication along with back of hand knowledge of your area and escape routes. Knowing that having multiples calls of a bomb threat come in to the Police as you initiate your op is a great way to stymie response times etc. Creating chaos by blowing up fireworks etc near your target will take the focus off your work on the target. Distractions have been a military tactic forever for a reason.

There is no communication or coordination needed between cells.

Info is obtained by watching the news of other cells actions and adjusting according to their successes/failures. The more cells that form, the more cells that WILL form. The news reporting on your op only serves to communicate the level of success, spurning on more successes.

This structure is immune to infiltration.

This structure is impossible to contain.

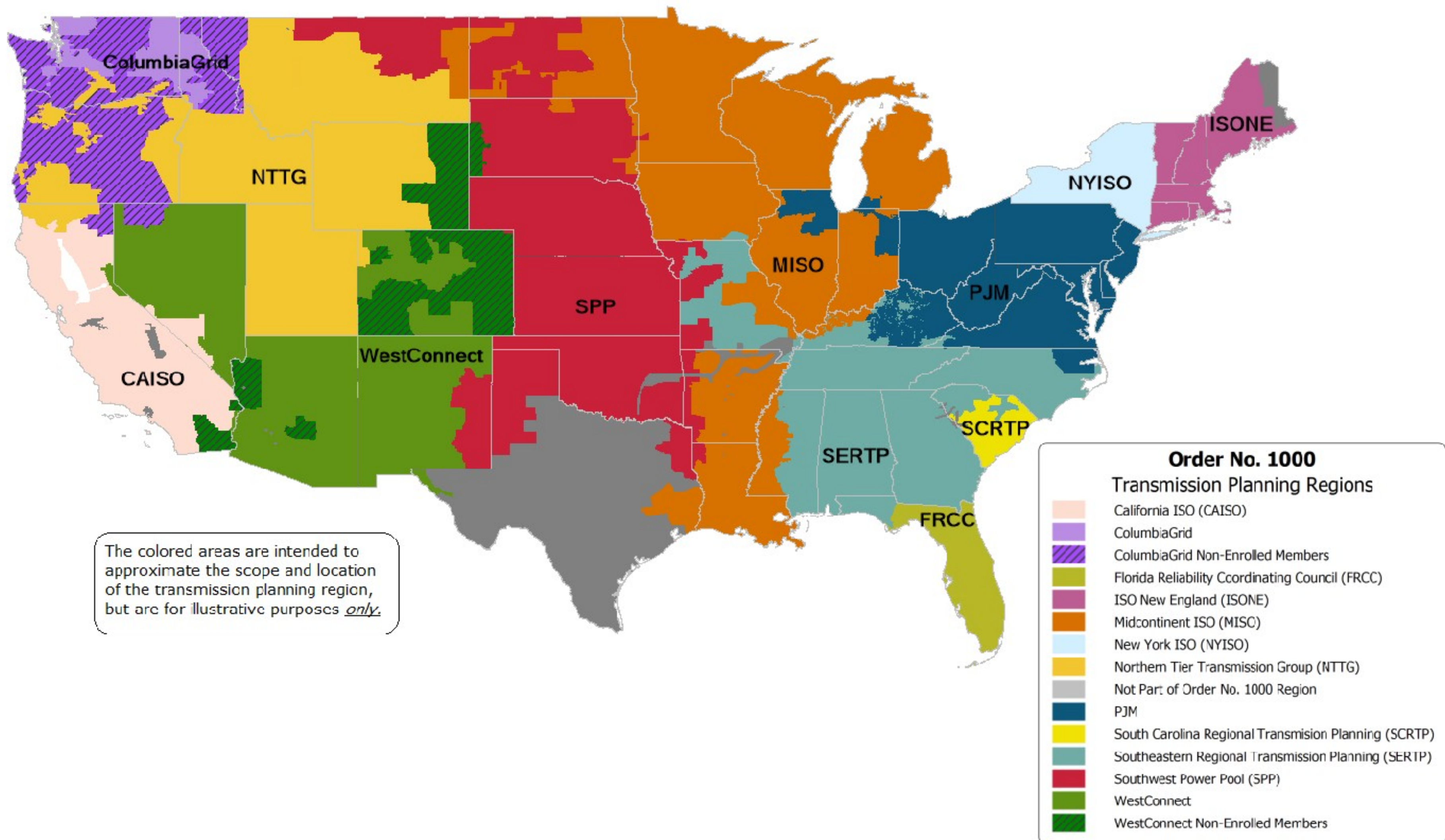
No one talks, everyone walks.

A thought on symbolism; this is an ego issue. DO NOT LEAVE A CALLING CARD. EVER. It's a piece of intel that allows globohomo to create intel maps and begin coordinating.

NO CALLING CARDS. NO EGO. NO ONE TALKS. EVERYONE WALKS

Order No. 1000

Transmission Planning Regions



LADWP Reminds Customers to Keep Mylar Balloons Away from Power Lines

f Share

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in Share

Stray metallic balloons cause an average of 200 power outages a year in L.A.

LOS ANGELES (June 11, 2018)—During this time of year, flower leis, personalized cards and balloons are popular gifts for graduation ceremonies as well as Father's Day. The Los Angeles Department of Water and Power (LADWP) reminds our customers that metallic balloons, or Mylars, can cause power outages and pose a public safety risk. Each year, Mylar balloons cause approximately 200 power outages—about one Mylar-related outage every other day in the City of Los Angeles.

Over two weeks in May 2018 (May 14-27), Mylar balloons caused 36 community-wide outages and affected more than 43,300 homes and businesses—nearly 45 percent of the total number of customers affected by power outages during those two weeks. On May 10, a 12-hour, community-wide Mylar-related outage in the Harbor/Gateway community occurred, affecting 2,450 customers.

The metallic coating on Mylar balloons conducts electricity, and can cause a short circuit or power surge when in contact with power lines. This can lead to large-scale power outages, melting of electrical wires, and fires, leading to possible injuries and property damage. In addition, outages caused by balloons can often result in traffic congestion due to disrupted traffic signals, and cause a significant inconvenience for residents and business owners who lose power.

“Unlike latex balloons, Mylar balloons can stay inflated and float in the air for two weeks or more, posing a safety risk to our utility workers and the public,” says Andrew Kendall, LADWP Senior Assistant General Manager, Power System

Construction, Maintenance and Operations. “The safety of our customers and utility workers is always LADWP’s top priority. We urge our customers to heed this warning and do their part in keeping their communities safe.”

To reduce the risk of outages and potential injuries, here are some important tips on how to safely and properly handle Mylar balloons:

- Never release a Mylar balloon outdoors
- Keep Mylar balloons away from power lines
- Use balloon weights
- Never use metallic ribbon with metallic balloons
- Always deflate metallic balloons and dispose of them properly when no longer in use

The above safety tips for proper handling of Mylar balloons are taken from California Penal Code Chapter 1559 Section 653.1. Florists and other merchants should always make certain that Mylar balloons are properly weighted, and should remind their customers not to release them outdoors.

If you see a Mylar balloon that has contacted a power line, keep yourself, your equipment, and all other items and people, at least 20 feet away. Always assume the power lines are energized. Do not attempt to climb the pole or try to retrieve the object. Call LADWP at 1-800-DIAL DWP.

###

Contact Us

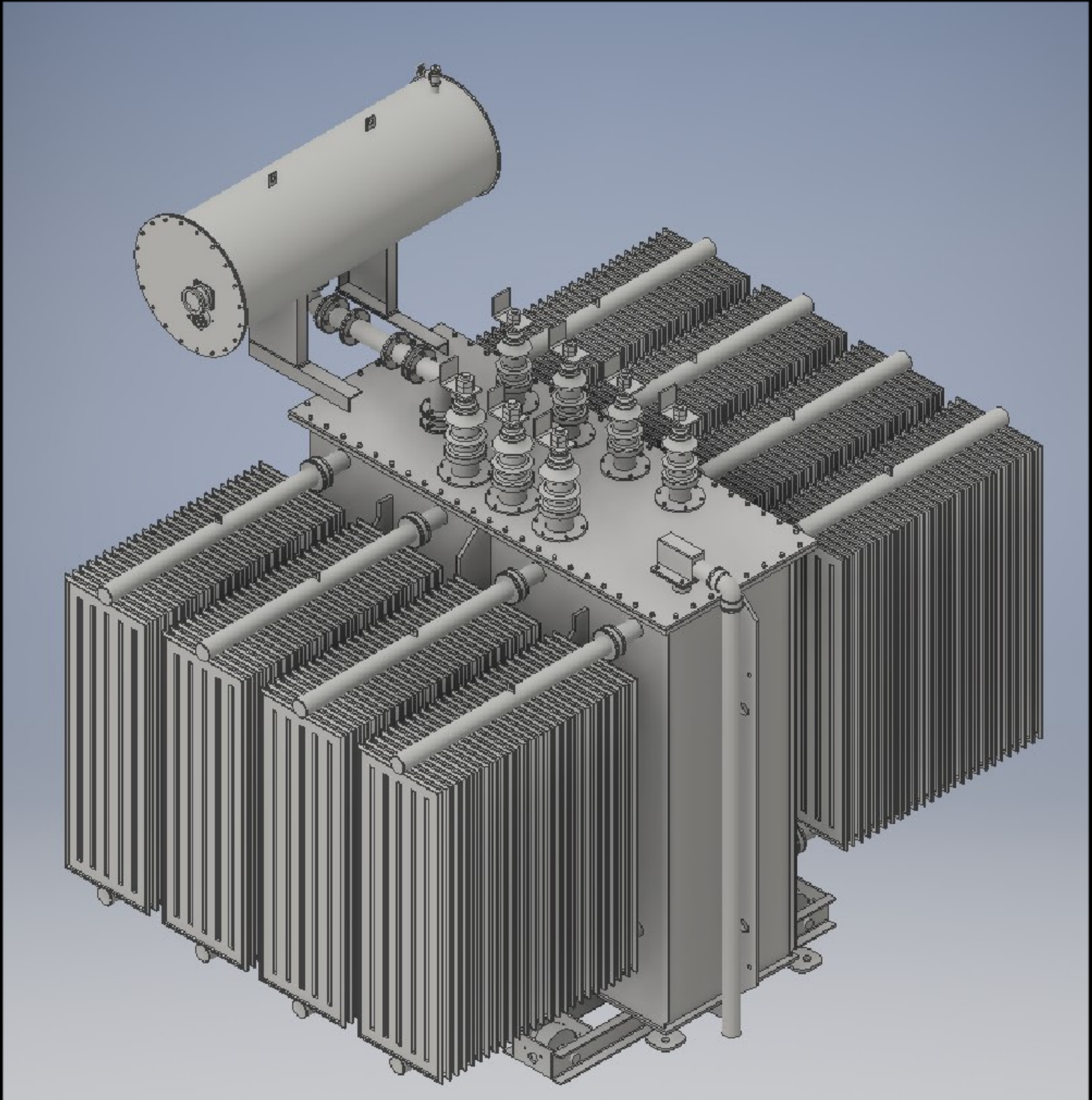
To email Customer Service :

www.ladwp.com/CustomerService

To report a power outage or water main break :

Call 1-800-DIAL-DWP (1-800-342-5397)

You may also go to www.ladwp.com/outages
to report a power outage.



Observe. This thing is your enemy and without it, you can have whatever you dream.

Ever want to rape two girls at the same time at gunpoint but never could because rape is illegal?

Ever want to steal \$1,000,000,000 in platinum with some buddies but couldn't because of all the cameras, cell towers, forensic technologies, cell towers connected to GPS and silent alarms?

Without the electrical **NIGGER** JEW, you would be able to do all this shit and more ;)



FUCK ELECTRICAL TRANSFORMERS AND FUCK ELECTRICITY!!!

IF YOU LIKE THESE THINGS, YOU ARE FUCKING **GAY!!**

MASS SHOOTINGS ARE FAKE GLOWNIGGER EVENTS!!

MASS SHOOTINGS EXIST TO DISTRACT FROM REAL STORIES!!

MASS SHOOTINGS ARE ALLOWED SO THAT GLOWNIGGERS GAIN FUNDING!!

THE GLOWNIGGER FEARS THE SABOTEUR!!

THE GLOWNIGGER LOVES DRIVE-BY SHOOTINGS!!

THE GLOWNIGGER LOVES SCHOOL SHOOTINGS!!

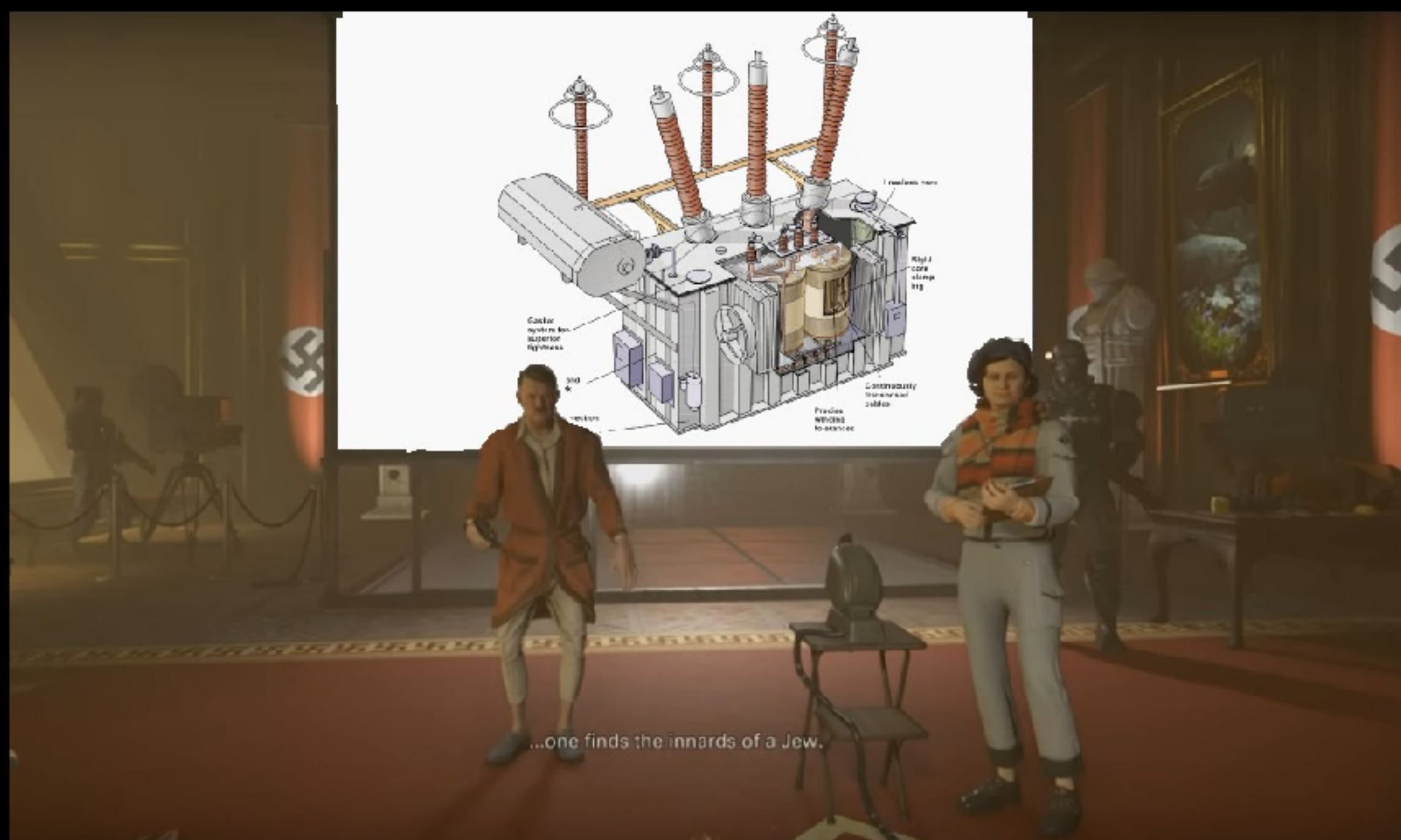
THEY LOVE DOMESTIC DISPUTES AND STAND-OFFS!!

THE GLOWNIGGER, CUCKOLD, SISSY-TURNED BITCH HATES, HATES, HATES WHEN A *BASED ASS ELECTRO-NIGGER HATING MOTHERFUCKER* WITH A BOLT-ACTION BIPOD AND A BRASS CATCHER WITH .308 FMJ BULLETS AND SPARK GAP TRANSMITTERS LIGHTS UP AN ELECTRICAL SUBSTATION, ELIMINATING THE POWER OF THE ELECTRICAL JEW!

INSTEAD OF GETTING MAD OR PLOTTING ON YOUR ENEMIES, GET MAD AT THE FUCKING METAL ELECTRICAL NIGGER JEW AND TAKE OUT YOUR ANGER ON THE EVIL MACHINATIONS OF ELECTRICITY, YOU STUPID FUCKS!!!!

The electrical transformer is gay!

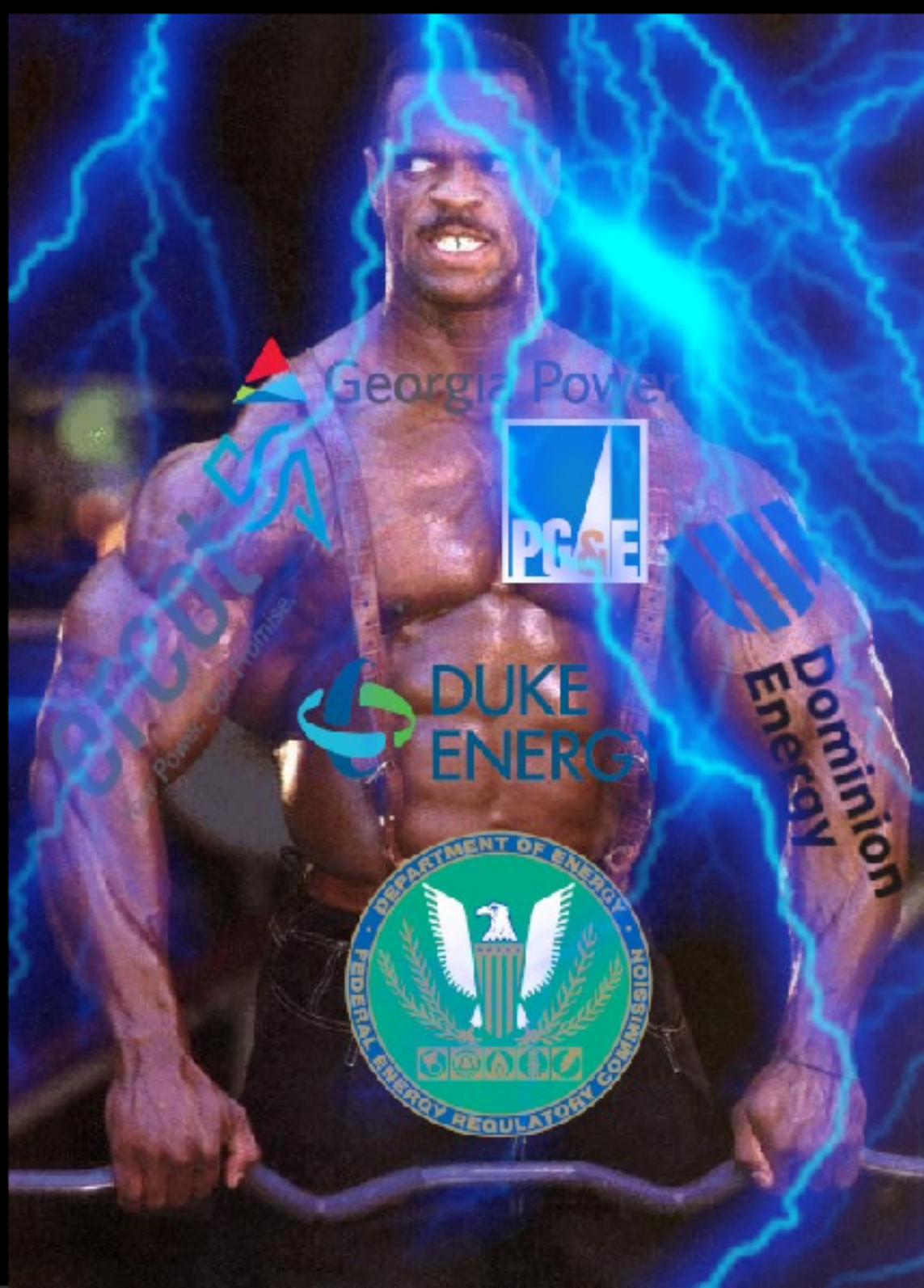
The electrical transformer is transgender!



The electrical transformer is a jewish nigger with three arms and a club foot!

TOTAL ELECTRICAL TRANSFORMER DEATH!!!!

THE ELECTRICAL TRANSFORMER IS THE BIGGEST GLOWNIGGER TO EXIST EVER!!



PRECISE TARGETING OF THE GRID



Imagine each X except the red X represents two or three well placed shots of .308 or 7.62 FMJ or AP bullets.

If a hypothetical substation had 17 transformers, multiply 2 or 3 x 17. Let's say 17, definitively, with 3 rounds per X.

102 rounds combined would be fired into the oil conservator tanks of all the transformers, 153 into the center mass of the 17 transformers overall, 102 rounds into all the bushings, 51 in the upper part of the control boxes, 51 in the lower part, 51 in the silica gel breathers.

To take out power to a substation with 17 transformers, you would need a minimum of 510 bullets, brass catchers, 5 gal buckets to empty the brass catchers into and to make 510 well placed shots. With five guys in a small cell, you would need four 50 round mags per man.

To avoid a repeat of the failures of Metcalf and Moore County, I have outlined what you need to do, step by step, based on common sense.

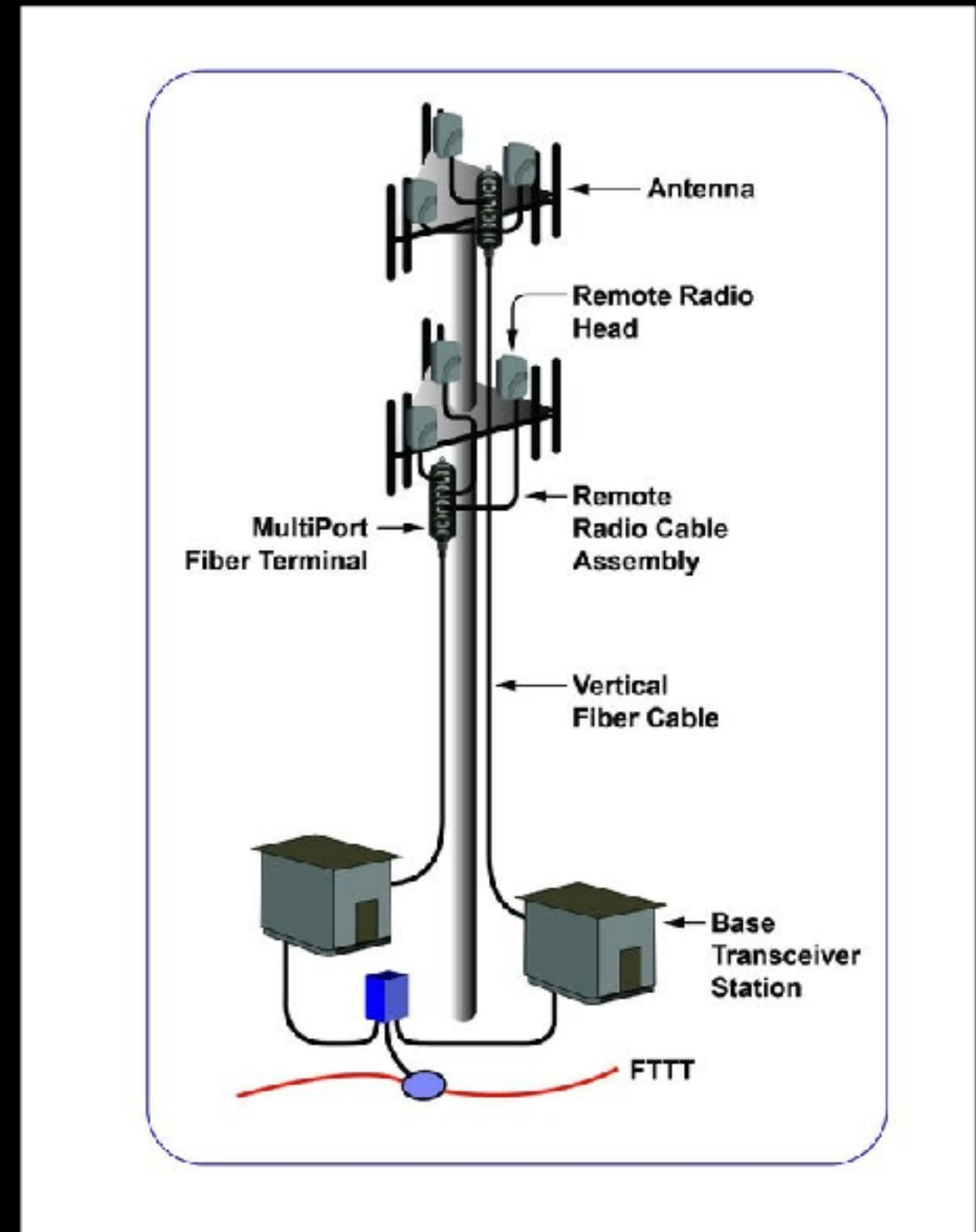
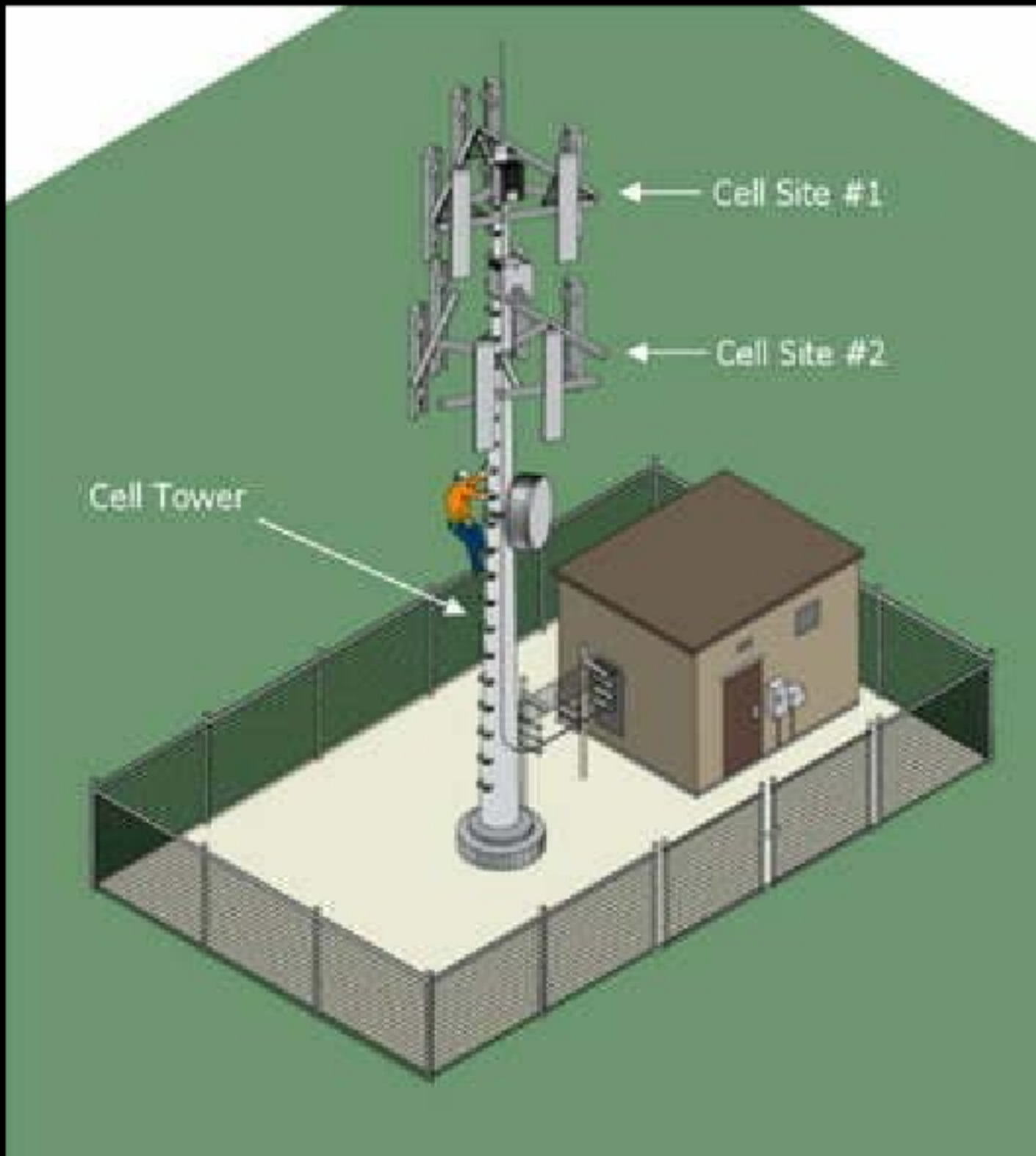
0. Leave your cellphones, bluetooth ear buds, any car made before 1980 or 1970s era, fitbit, smart watch at home. Cover up head to motherfucking toe. DO NOT leave your house with any technology! COVER UP HEAD TO FUCKING TOE, FULL FATIGUES/BDU, with all Black gloves, boots, balaclava, etc!!!! Learn to use paper maps and atlases. Take an old era battery powered hiking GPS if you absolutely must, like the Magellan Triton. Study and plan your target out well in advance.

1. Call in a major threat that is credible in a nearby region. For example, call in a multi-bomb threat at an airport. Use specific terminology like TATP or HMTD or PETN when talking about the explosives. Pick an explosive and stick with it in the call. Be specific about your bombs. Tell them you have EFPs or shaped charges inside three or four planes and they will detonate after an hour. This will draw a lot of police and they will ground flights and check the planes with a fine toothed comb which will take many hours.

2. Make sure that the airport or wherever is close to where your desired electrical substation target is so it pulls most of the police and glowniggers and EMS/Fire away.

3. Have or create spark gap transmitters before Step 1 and 2. Take them with you. Test them beforehand to make sure they work and will work on the scene.

4. Take a wooden handle axe and go to a few nearby cell towers. Using the axe, cut the fucking fiber optic cables. Alternatively, shoot them with multiple shots on the large black cables or put explosives on the box the cables run through, shown below:



See these black cables? Destroy them so people can't call 911 when you light up the power grid.



The black fiber optic cables on the side of the cell tower carry the signals for broadcast. Here is how cell towers work:

Cell Phone Tower Pictures



Cell phone towers come in many shapes and sizes. Learn how to recognize cell phone towers and how they use their equipment to communicate with your phone.



Cell phone towers come in many shapes and sizes - such as a tower made to look like a tree.



The base of a cell phone tower.



Multiple locks on a gate around a cell phone tower usually indicate multiple service providers.



HOWSTUFFWORKS.COM

The box houses the radio transmitters and receivers that let the tower communicate with the phones.



HOWSTUFFWORKS.COM

The radios connect with the antennae on the tower through a set of thick cables.





HOWSTUFFWORKS.COM

The tower and all of the cables and equipment at the base of the tower are heavily grounded. For example, the plate in this shot with the green wires bolting onto it is a solid copper grounding plate.





(C) ISTOCKPHOTO/JANE

If your cell phone isn't compatible with the frequencies coming from a tower, it doesn't matter what SIM card you're using.



5. Cut underground lines in the local area near the substation you plan to go after

	Red: Electric Power Lines, Cables, Conduit & Lighting Cables
	Yellow: Gas Oil, Steam, Petroleum or Gaseous Materials
	Orange: Communication, Cable TV, Alarm or Signal Lines, Cables or Conduit
	Blue: Potable Water
	Green: Sewers and Drain Lines
	Purple: Reclaimed Water, Irrigation and Slurry Lines
	Pink: Temporary Survey Markings
	White: Proposed Excavation



Cutting red flagged lines could potentially kill you. Do not cut underground power lines.
Cut underground communications cables!

They are flagged with orange flags:



Dig up where you see orange flags using a folding e-tool or shovel and using some bolt cutters or garden shears, cut the fiber optics cables. Hit two or three different locations to totally kill TV and phone lines.

6. Read
Gridnomicon
& apply the
tactics
within,
NIGGER!

Gridnomicon - Ways And Means To Take Out Electrical Power Infrastructure In
North America For Political Motivations
An Outside Observation

Disclaimer:

I am writing this tutorial only because we have seen a right-wing and a left wing attack occur in the same fucking month that both successfully caused blackouts on opposite ends of the fucking country. This shit is so motherfucking based and I personally hope whoever is doing this shit never stops doing it and never gets caught.

I am in no way whatsoever involved in this shit. As an outside observer, I would like to contribute my two cents to those who seek to take out the grid, to those worried about the grid and to the heroes who did Metcalf, Moore County and Tacoma. I fully support whoever is doing it and I want you to know I love you so much from the bottom of my heart.

Fuck glowniggers, fuck the regime and fuck America.
Never stop, you mad lads.

Foreward:

One good thing about the news, which is the fourth branch of U.S. Government, is the fact that they sensationalize shit that should never be talked about. Moore County and Tacoma should have never been on national news, nor social media. If the United States government was intelligent, they would have fucking been clandestine with a media blackout, but, you can't expect a faggot amalgamation army of kikes, niggers, spics and trannies to understand human psychology. Instead, they downplay it as "burglaries" and "vandalism." This is downplaying in the hopes people do not see the seriousness of the impact and is also a reverse psychology tactic. The truth is this is not burglaries, nor is it vandalism. It is terrorism. This is the same as school shootings, as far as sensationalizing is concerned. Once the genie is out of the bottle, once the idea has spread and entered minds, it will never go back in. Now, the disgruntled have an easy target. I expect that the grid will now be shot up every hour on the hour, thanks to this shit. It's only going to get worse and, fuck you, it should.

Assassination is high risk, low reward. There is a possibility that you could get away with assassination of someone. A slight possibility. However, murder is solvable and has no statute of limitations. Period. Kill someone and you could be a quantum computing AI or a breakthrough forensics analysis network or a telepathic brain scan away from a murder charge. You could assassinate politicians or cops or communists or journalists or fascists or jews but you can't kill a system or an idea. An idea only dies when people no longer respect it enough to follow it or even see aspects of it which resonate with them in a way that they can connect to it, at the point in their life when they first encounter the idea. A system only dies

By shooting up electrical substations, using drones to drop graphite powder or by setting the transformers themselves on fire, you can take out the power grid. It is highly unlikely anyone will die. But if they do, it's highly unlikely you will be caught, unless you are a fucking idiot. Don't be dumb.



Metcalf

We have to talk about Metcalf before we talk about anything. Metcalf was the pioneer of infrastructure attacks. Metcalf is to this shit happening today what Lexington and Concord are to the American Revolution. Metcalf was a masterpiece. It was brilliant in nearly every way. If we are to talk effort, they deserve an A+ for that shit. If we are to talk planning and efficiency, they again, deserve an A+. If we are to talk success, then ultimately, Metcalf was a failure. First off, they were able to reroute power. So, the grid never even went down. That appears to be an insider attack or a probing attack. Metcalf was done so meticulously and thoroughly that if they really wanted to, they could have taken out the grid. But, they didn't.

Why Metcalf Failed:

- They did not build several spark gap transmitters to jam the radios the crew at the substation used to communicate.
- They did not kill the on-site crewmen. You want Blackout? Kill the people paid to stop one when you go to shoot the place up.
- They did not suppress their rifles to confuse concerned people in the area as to the direction of the gunshots.
- They did not bring a jammer that would jam radio and cell service because the crewmen could have still called 911.
- They did not lure Police/Fire/EMS somewhere else with a hoax bomb threat on a airport or hospital.
- They fired indiscriminately from a vantage point with AK-47s.
- They did not release a bunch of mylar balloons to short circuit everything and then take shots at key parts of every transformer.
- They did not bring down a cell tower by cutting the big ass fiber optic cable connected to it with a wood handled fire axe.

Metcalf was done horribly fucking wrong. They should have cut cell towers as well as that area's underground phone lines.

They should have jammed broadband radio.

They should have aimed at the bushings/insulators, the tanks, the breathers, the center mass of the transformer.

PG&E was able to radio out so power was redirected.

People were able to call 911 so police interrupted the attack.

Crewmen were not killed so they were able to call for help.

The only good thing they did was using flashlights for subvocal communication and cutting the underground landline phone lines before the attack.

Biggest fuckup of Metcalf:

- Using AK-47s. They should have used bolt action scoped rifles. Or green tip .556 ammo in some AR-15s with a brass catcher.

- Not using brass catchers. They left over a hundred casings.
- Not killing on site personnel who later rerouted power.
- Not jamming broadband radio.
- Not making a hoax bomb threat on a airport to redirect 70% of the police miles away.

Metcalfe was fucked up. But it was beautiful. A beautiful failure. The perfect thing they did in Metcalfe was cutting the phone lines. It was the best attempt so far to attack the power grid.

And now, a diagram of a transformer:
<https://circuitglobe.com/what-is-a-transformer.html>

And lastly, the vulnerable points on a transformer are:

- The Oil Conservator Tank
- Ceramic Bushings
- Core Winding
- Silica Gel Breathers

You shoot these with a scoped rifle at 2 story level elevation with cover from bushing shrapnel. Do not fire indiscriminately from a spider hole and leave 100+ shells on the ground. I know retarded people will read this so let me explain to you:

Cut the fucking cable to a cell tower, no E911

Shoot breathers, overheating

Shoot oil tank, overheating and not cooling

Shoot bushings, no way to connect as the circuit is stopped.

Shoot iron core, winding is being ripped by bullets, not connecting.

Shoot personnel, they can't radio for help.

Bring spark gap transmitters or radio jammers. They jam broadband radio.

Spark Gap Transmitters:

<https://youtube.com/watch?v=SnKKj2bonAI>

https://en.wikipedia.org/wiki/Spark-gap_transmitter

<https://www.electronics-notes.com/articles/history/spark-gap-transmitters/operation-how-does-spark-gap-transmitter-work.php>

<https://steemit.com/steemstem/@proteus-h/diy-spark-gap-radio-transmitter-and-explanation>

<https://www.instructables.com/Simple-broadband-jammer/>

<https://youtube.com/watch?v=U8HKgoV5dAQ>



Lattice Steel Transmission Towers, aka, Pylons:

- A pylon, or transmission tower, is like the WiFi repeater of power. It carries power from the distribution substations to your neighborhoods' power poles and from there to the stepdown transformer on said pole and then into your house. Without pylons and stepdown transformers on power poles, you would not have a grid. They sustain the overhead power lines.
- Pylons are made of steel. Steel can be cut like butter with the right shit.

- A two-handed reciprocating saw can be used to cut down a steel transmission tower.
- The best blade to cut steel is a carbide-steel, bi-metallic blade, aka "Sawzall" type blades.

Links To Videos And Wikis On Pylons/Lattice Steel Transmission Towers:

https://en.wikipedia.org/wiki/Transmission_tower
<https://www.drax.com/technology/the-history-of-the-pylon/>
https://en.wikipedia.org/wiki/Overhead_power_line
<https://youtube.com/watch?v=Itf5L3j11zQ> - Pylon Explodes Into Fireball
<https://youtube.com/watch?v=8XdmBnAlKIw> - Building A Pylon
<https://youtube.com/watch?v=0Y72athcwvA> - Power Line Blast
<https://youtube.com/watch?v=B3uBtl4EeFo> - Pylon Falls On Car

Links And Videos On Reciprocating Saws And Blades:

<https://www.toolboxbuzz.com/cordless-tools/reciprocating-saw/cordless-reciprocating-saw-head-to-head/>
<https://youtube.com/watch?v=UWQBiLmbduQ> - Best Saws, Ranked
<https://youtube.com/watch?v=Wg1VzqhhKcs> - Best Cordless Reciprocating Saws Of 2020

<https://youtube.com/watch?v=uclHFP1pFZ4> - Sawzall Blade Cutting Metal

• If you cut down a pylon, you will remove a pylon from a long line of pylons from the substations to the cities. There will be some consequences of this. You will not end every light in existence, nor will you bring down a whole part of your state. One thing is for certain: It will take weeks to repair and your city will be blacked out for a while. They will have to go make a new pylon, turn off the local grid, go install the pylon with cranes and bolt it to the ground, connect it to the others with cables and turn that area's part of the grid back on. Not to mention, millions of dollars in damages.

• "Sawzall" blades are those bimetallic carbon-steel blades that you can saw through steel with.

• Diablo™ bimetallic blades are the best for cutting the type of steel found on pylons.



Non-Nuclear Electromagnetic Pulses, Lulz And You
Context:

- https://en.wikipedia.org/wiki/Electromagnetic_pulse
 - <https://www.youtube.com/watch?v=TWceSnGVtR8>

RF Suitcases:

<https://www.apelc.com/rf-suitcase/>
<https://celestia-sts.com/egse/integrated-systems/rf-suitcase/>
<https://austria-in-space.at/en/projects/2010/generic-rf-suitcase-core.php>
<https://www.apelc.com/high-power-rf/>
<https://celestia-sts.com/2019/successful-delivery-of-euclid-rf-suitcase/>
<https://celestia-sts.com/2018/euclid-spacecraft-rf-suitcase-contract-award/>
<https://laboratorytalk.com/article/240578/satellite-testing-helps-solve>
<https://www.koreascience.or.kr/article/JAK0200642872176361.jsp-kj=SSMHB4&py=2012&vnc=v27n6&sp=588>
https://www.ercim.eu/publication/Ercim_News/enw22/cluster.html

You can use an RF suitcase - an integrated RF subsystem - to fry life support in hospitals, critical infrastructure and water/power generation, take out servers, take out corporations, take out security cameras to banks/bunkers/military bases/police stations/etc to irreversibly destroy electronics and/or cover your tracks. You can also easily create these devices at home to take out anything that has no electromagnetic shielding. It is basically a giant spark gap emitter.



Moore County And Tacoma

Moore County was obviously a highly sophisticated attack. It's painfully obvious that whoever hit that shit knew just what they were doing if they were able to cause an outage lasting days.

Which leads me to seven theories:

- 1) Emily Rainey and some of her Fort Bragg army buddies lit that shit the fuck up. She was a psy-ops officer for the Air Force. By attacking the grid on the day of the drag show, people begin to blame the right for the attack openly and people can push the narrative of a hate crime. This will also garner the most controversy, ensuring nationwide media attention, causing the information of power grid vulnerability to go mainstream so that future attacks can occur via the copycat effect.
- 2) Some right wing North Carolina survivalists with Baofeng radios or stopwatches and impeccable synchronization attacked the grid at the same time because of the state sanctioned drag queen performance. In theory, it was just that. Angry conservative boomers with nothing better to do, who after a few beers, hopped in the 4x4 or the trailer or the Walmart scooter and did a drive-by protest on the grid.
- 3) Feds shot up the infrastructure to garner support for federal agencies, for an increase in their annual funding, as well as funding for infrastructure hardening, via electric fencing, concrete walls, netting or ballistic blankets/ballistic plating.
- 4) Some former Duke Energy employees mad for some reason or another decided to shoot up the power grid in North Carolina.
- 5) It was corporate warfare from the electrical industry and this is basically corporate sabotage from another electric service provider trying to put Duke Energy out of business or initiate some kind of corporate merger to obtain Duke Energy for a low price after causing a stock price plummet.
- 6) Mexican cartels, Russian, Chinese or Iranian sleeper cells, i.e., foreign organizations or foreign operatives took out the grid.
- 7) Someone is trying to rob something and so they took out the grid to knock out intrusion detection systems, cameras or silent alarms.

[illegible]

Pandora's Box

What can you do as a pleb civilian?

- Buy quilts, comforters and blankets.
- Get a deep freezer that is insulated.

What can the power companies and the regime do?

- Fuck all nothing.
- Erect concrete walls.
- Put netting of some kind on the top of the substation.
- Build them underground.
- Connect an air raid siren to each substation so when the grid is shot up, the air raid/storm siren kicks in and sounds off that something or someone has just taken out power. If a storm, it would double as a warning that a storm is in the area. If a person, it would definitely sound off that someone was there.
- Electrify the fences so that no one can cut them and get in unless they are linemen with special equipment.
- Build enclosures around the substation, making a giant hanger above it.
- Have drones for aerial surveillance.
- Put up trail cameras.
- Arm the guards.
- Place automatic turrets near substations with a near 180° targeting radius that will not sweep the substation.
- Arm the linemen/on-site personnel.
- Bring domestic manufacturing of transformers here, create a DOE mobile command fleet and increase supply of mobile transformers
- Make it a capital offense to attack the grid.
- Put solar panels in all new homes
- Create capacitor banks that store surplus energy.
- Harness lightning.
- Place traps at the perimeter that only staff can get around.

What will happen ultimately?

- The big guy will get 10%.
- Israel will get more money.
- Zelenskyy will get his monthly six gorillion, and, cocaine from Peru.
- The uniparty will bicker and nothing will get done.
- Energy companies will refuse to shell out the money as fortification of all the substations, of which there are at least 77,000, meaning this problem will never be solved.
- The uniparty faggots in DC will receive \$174,000 in annual taxpayer salary, both House and Senate and they will continue to do insider trading but if you have \$600.01 in your bank account, you will be audited.
- Due to the cost being astronomical and debts being so high, nothing can be done. Certain municipalities will try to harden their regional substations but in the end it will not go beyond walls and more cameras.
- Nothing.



Methodology

and John take off your gloves and toss them into the pile of clothes in the backseat of the stolen car, on top of all the clothes. You change into your street clothes. Eddie then takes the blocks out, using his gloves, placing two on the dashboard, two under the front seat, three under the hood two in the backseat on the pile of clothes and one in the trunk with the plastic containers and the suitcase. Eddie puts newspaper or some kind of kindling near all the blocks. He then takes off his gloves and tosses them in the pile. Ray opens and pours four bottles of water on Eddie's hands. Slowly. Two for each hand. Ray collects the water bottles and caps and tosses them in the back of the pickup with the guns from the job. Eddie then takes off his black clothes and changes, putting on everything but the jacket. Eddie then pours kerosene or gas on the piles in the trunk, on the hood of the stolen car and pours some on the ground. Eddie pulls the stolen phone out. He puts the SIM and the battery in. He turns on the phone and calls in a bomb threat at the largest local airport. He hangs up immediately after the threat is made, takes the battery out, tosses it in the car. He pulls out the SIM and breaks it with his thumbs, placing it in the car, on the pile of clothes. He tosses the phone in also. He then sets all the piles on fire with a store bought click lighter made for lighting grills and stoves by lighting the trail on the ground. Since you, John and Ray are in the truck and since you are a few yards from the car, you're safe. Eddie lights the trail with the click lighter, being sure to keep his feet away from it, so as to not catch on fire. Once lit, he steps back. He's not on fire. None got on his shoes. Good. Eddie gets in the truck and you drive off. By morning, the car is an ashen frame. No fiberglass, no glass, no fabric. Just a hollow frame that used to be a stolen car. No evidence of who or why. All DNA is gone. All clothes are gone. Even the suitcase. Even the plastic. The mission, successfully completed. Another day, another news story, another cold case like Metcalf. No suspects. No motives. No manifesto. No one bragging or claiming responsibility.

Nothing but silence.



How The Transformers Should Go Down In Your Story

You could cut the fence or the lock with Olympia folding bolt cutters in a backpack. Once you're in, you could pour some gas or lighter fluid on the transformers by using a ladder or something to get on the top. Pour the shit on the transformers. Burn the pooling trail on the sides and bottom of the transformers and get the fuck out of there. Fire is Antifa shit and is not really efficient if you want a grid failure. The most effective grid attack to date appears to be Moore County so you will need to shoot these things up.

The best way is to break in, put jars of Tannerite on top of the transformers, between the ceramic bushings on each of the transformers, leave and get some distance and light the substation up.

Alternatively, you could do precision shooting by having red dots and lasers. Zero out your shit in the woods or out of town with some range practice. With 250 rounds per man, five fifty round mags, that's 25 transformers per man. 100 per cell that you could take down. If there are

like 20 transformers per substation, you could take out five substations like this. So imagine 500 rounds per man and ten 50 round mags per man. Realistically, it will go like this, three shooters, one man on shell collection duty. And also realistically, you will use one man per transformer so it will be like a relay race. The other two guys will have to use a mag per transformer. Until all the transformers in the substation are shot up. Once this is done, go to the next substation fast. Get the fuck out of the area after. You should know when to quit. According to the news, Moore County required two substations to go down for 45,000 people. To take out an entire city like Portland, you'd need about 100 guys or less, which is too many people. You could only really do this to provide cover for looting, robbery, an assassination in an area with cameras, kidnapping or at very critical substations. If you want to commit a murder or a robbery, a blackout will kill the cameras and alarms and give you cover. Criminals should definitely start doing it if for no other reason to provide cover for their crimes.

Just going to throw some random numbers out here:

Five rounds in the oil conservator tank of the transformer, 45 rounds left. 10 rounds center mass into the transformer, 35 rounds left.

Two bullets per ceramic bushing unless you are a U.S. Army Marksman or better. So if there were six bushings, that's 6 - 12 shots. 23 - 29 rounds left.

Two rounds into the silica gel breather. 21 - 27 rounds left.

Five rounds into the control cabinet. 16 - 22 rounds left.

Magdump the rest on the center mass of the transformer.

Once the mag is empty have your shell man collect the shells. Let's say John is the shell man. John collects the shells from your brass catchers in the buckets. You reload. When the bucket is full, he gets another bucket, ad infinitum, until it's done.

Now, the Garmin GPS, the buckets of brass casings and the gear like the rubber gloves, the saws, the bolt cutters, that shit all comes with you from the operation. You keep that for the last phase - melting the brass casings into brass ingots, tossing and replacing the barrels, ejectors, extractors and firing pins in your rifles, planning future operations.

The stolen car, the stolen phone, the black combat clothes, you burn that. Although, you could keep the clothes. It's not exactly going to get you in trouble unless you are found with it in your house. But that would only happen if you become a suspect and a search warrant is issued. And that would never happen if you follow this guide to the letter and have no snitches among you.

I suggest you don't keep it at your house but a location where you can all suit up for a new operation. A cabin one of you may own, perhaps. Under some floorboards or in a safe, with a grill or something nearby to burn the clothes within the hour. Not in your homes or vehicles. Probably under the cabin itself.



Spark-gap transmitter

A **spark-gap transmitter** is an obsolete type of radio transmitter which generates radio waves by means of an electric spark.^{[1][2]} Spark-gap transmitters were the first type of radio transmitter, and were the main type used during the wireless telegraphy or "spark" era, the first three decades of radio, from 1887 to the end of World War I.^{[3][4]} German physicist Heinrich Hertz built the first experimental spark-gap transmitters in 1887, with which he proved the existence of radio waves and studied their properties.

A fundamental limitation of spark-gap transmitters is that they generate a series of brief transient pulses of radio waves called damped waves; they are unable to produce the continuous waves used to carry audio (sound) in modern AM or FM radio transmission. So spark-gap transmitters could not transmit audio, and instead transmitted information by radiotelegraphy; the operator switched the transmitter on and off with a telegraph key, creating pulses of radio waves to spell out text messages in Morse code.

The first practical spark gap transmitters and receivers for radiotelegraphy communication were developed by Guglielmo Marconi around 1896. One of the first uses for spark-gap transmitters was on ships, to communicate with shore and broadcast a distress call if the ship was sinking. They played a crucial role in maritime rescues such as the 1912 RMS Titanic disaster. After World War I, vacuum tube transmitters were developed, which were less expensive and produced continuous waves which had a greater range, produced less interference, and could also carry audio, making spark transmitters obsolete by 1920. The radio signals produced by spark-gap transmitters are electrically "noisy"; they have a wide bandwidth, creating radio frequency interference (RFI) that can disrupt other radio transmissions. This type of radio emission has been prohibited by international law since 1934.^{[5][6]}

Theory of operation

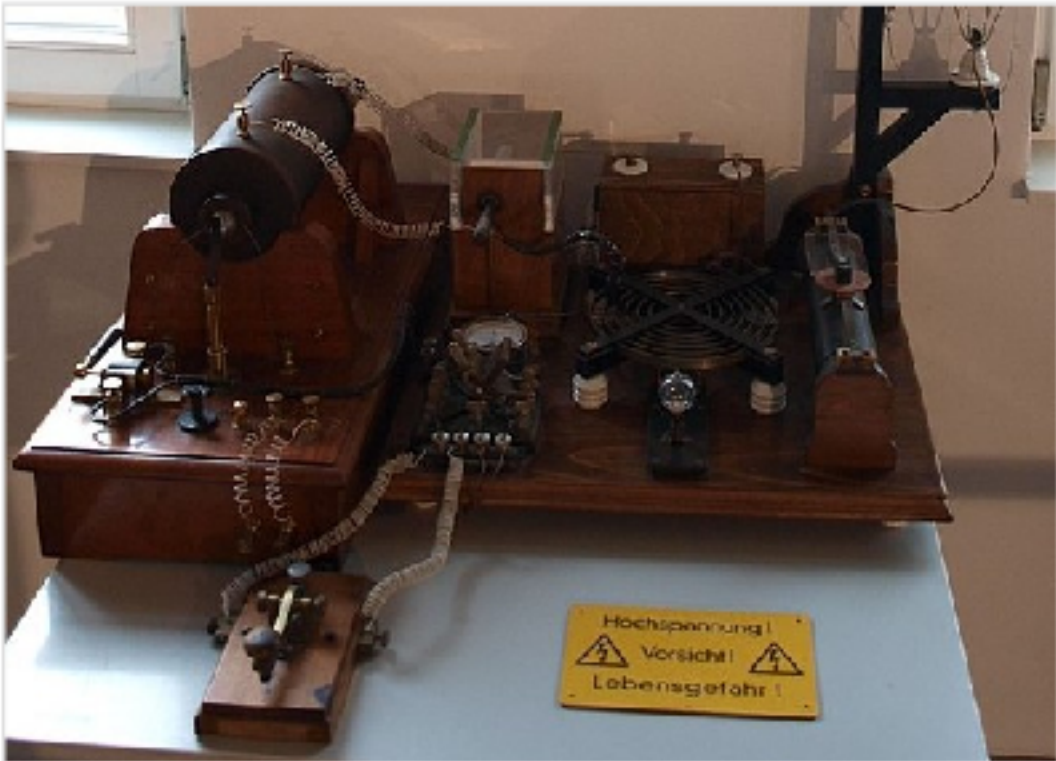
Electromagnetic waves are radiated by electric charges when they are accelerated.^{[7][8]} Radio waves, electromagnetic waves of radio frequency, can be generated by time-varying electric currents, consisting of electrons flowing through a conductor which suddenly change their velocity, thus accelerating.^{[8][9]}

An electrically charged capacitance discharged through an electric spark across a spark gap between two conductors was the first device known which could generate radio waves.^{[10]:p.3} The spark itself doesn't produce the radio waves, it merely serves as a fast acting switch to excite resonant radio frequency oscillating electric currents in the conductors of the attached circuit. The conductors radiate the energy in this oscillating current as radio waves.

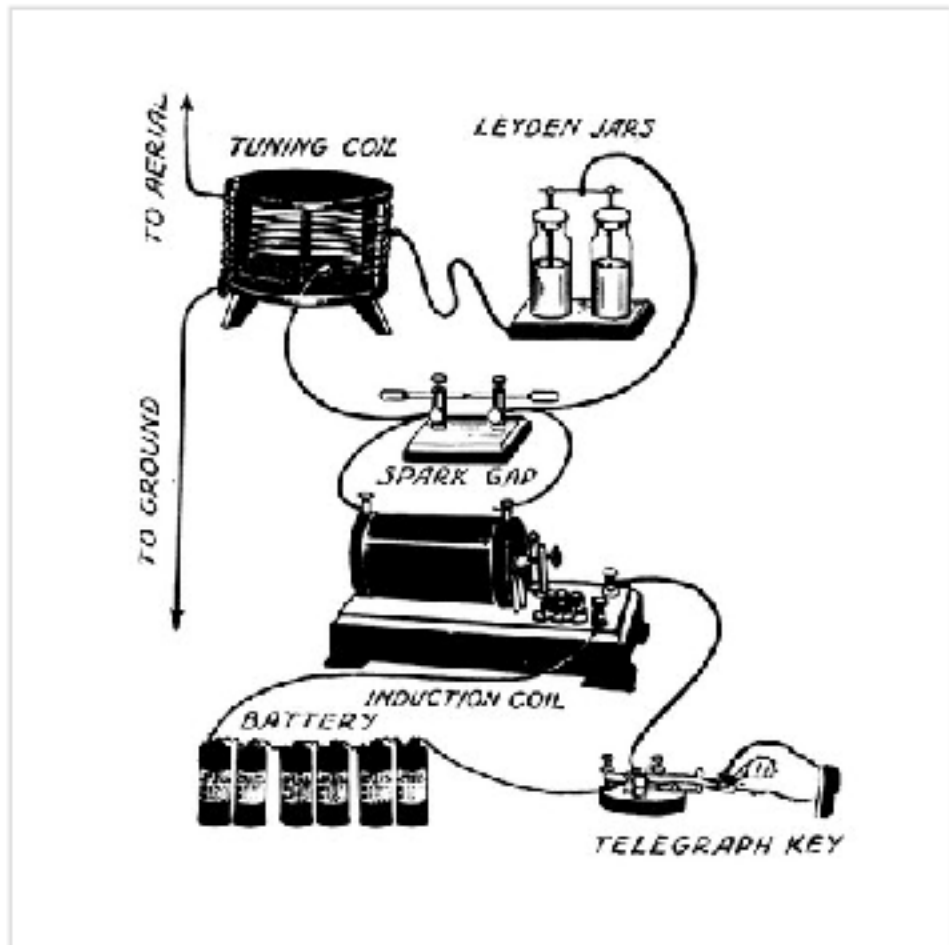
Due to the inherent inductance of circuit conductors, the discharge of a capacitor through a low enough resistance (such as a spark) is oscillatory; the charge flows rapidly back and forth through the spark gap for a brief period, charging the conductors on each side alternately positive and negative, until the oscillations die away.^{[11][12]}

A practical spark gap transmitter consists of these parts:^{[11][13][14][15]}

- A high-voltage transformer, to transform the low-voltage electricity from the power source, a battery or electric outlet, to a high enough voltage (from a few kilovolts to 75-100 kilovolts in powerful transmitters) to jump across the spark gap. The transformer charges the capacitor. In low-power transmitters powered by batteries this was usually an induction coil (Ruhmkorff coil).
- One or more resonant circuits (tuned circuits or tank circuits) which create radio frequency electrical oscillations when excited by the spark. A resonant circuit consists of a capacitor (in early days a type called a Leyden jar) which stores high-voltage electricity from the transformer, and a coil of wire called an inductor or tuning coil, connected together. The values of the capacitance and inductance determine the frequency of the radio waves produced.
 - The earliest spark-gap transmitters before 1897 did not have a resonant circuit; the antenna performed this function, acting as a resonator. However, this meant that the electromagnetic energy produced by the transmitter was dissipated across a wide band, thereby limiting its effective range to a few kilometers at most.
 - Most spark transmitters had two resonant circuits coupled together with an air core transformer called a *resonant transformer* or *oscillation transformer*.^[11] This was called an *inductively-coupled* transmitter. The spark gap and capacitor connected to the primary winding of the transformer made one resonant circuit, which generated the oscillating current. The oscillating current in the primary winding created an oscillating magnetic field that induced current in the secondary winding. The antenna and ground were connected to the secondary winding. The capacitance of the antenna resonated with the secondary winding to make a second resonant circuit. The two resonant circuits were tuned to the same resonant frequency. The advantage of this circuit was that the oscillating current persisted in the antenna circuit even after the spark stopped, creating long, ringing, lightly damped waves, in which the energy was concentrated in a narrower bandwidth, creating less interference to other transmitters.
- A spark gap which acts as a voltage-controlled switch in the resonant circuit, discharging the capacitor through the coil.
- An antenna, a metal conductor such as an elevated wire, that radiates the power in the oscillating electric currents from the resonant circuit into space as radio waves.
- A telegraph key to switch the transmitter on and off to communicate messages by Morse code



Low-power inductively coupled spark-gap transmitter on display in Electric Museum, Frastanz, Austria. The spark gap is inside the box with the transparent cover at top center.

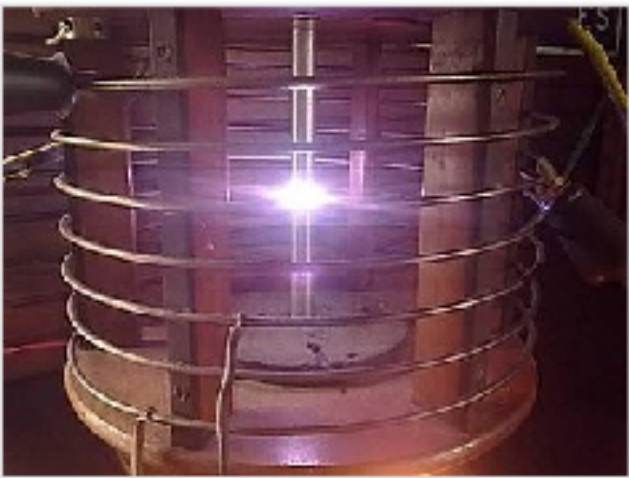


Pictorial diagram of a simple spark-gap transmitter from a 1917 boy's hobby book, showing examples of the early electronic components used. It is typical of the low-power transmitters homebuilt by thousands of amateurs during this period to explore the exciting new technology of radio.

Operation cycle

The transmitter works in a rapid repeating cycle in which the capacitor is charged to a high voltage by the transformer and discharged through the coil by a spark across the spark gap.^{[11][16]} The impulsive spark excites the resonant circuit to "ring" like a bell, producing a brief oscillating current which is radiated as electromagnetic waves by the antenna.^[11] The transmitter repeats this cycle at a rapid rate, so the spark appeared continuous, and the radio signal sounded like a whine or buzz in a radio receiver.

1. The cycle begins when current from the transformer charges up the capacitor, storing positive electric charge on one of its plates and negative charge on the other. While the capacitor is charging the spark gap is in its nonconductive state, preventing the charge from escaping through the coil.
2. When the voltage on the capacitor reaches the breakdown voltage of the spark gap, the air in the gap ionizes, starting an electric spark, reducing its resistance to a very low level (usually less than one ohm). This closes the circuit between the capacitor and the coil.
3. The charge on the capacitor discharges as a current through the coil and spark gap. Due to the inductance of the coil when the capacitor voltage reaches zero the current doesn't stop but keeps flowing, charging the capacitor plates with an opposite polarity, until the charge is stored in the capacitor again, on the opposite plates. Then the process repeats, with the charge flowing in the opposite direction through the coil. This continues, resulting in oscillating currents flowing rapidly back and forth between the plates of the capacitor through the coil and spark gap.
4. The resonant circuit is connected to the antenna, so these oscillating currents also flow in the antenna, charging and discharging it. The current creates an oscillating magnetic field around the antenna, while the voltage creates an oscillating electric field. These oscillating fields radiate away from the antenna into space as an electromagnetic wave; a radio wave.
5. The energy in the resonant circuit is limited to the amount of energy originally stored in the capacitor. The radiated radio waves, along with the heat generated by the spark, uses up this energy, causing the oscillations to decrease quickly in amplitude to zero. When the oscillating electric current in the primary circuit has decreased to a point where it is insufficient to keep the air in the spark gap ionized, the spark stops, opening the resonant circuit, and stopping the oscillations. In a transmitter with two resonant circuits, the oscillations in the secondary circuit and antenna may continue some time after the spark has terminated. Then the transformer begins charging the capacitor again, and the whole cycle repeats.



Demonstration of the restored 1907 Massie Wireless Station spark gap transmitter

Audio of Massie spark gap transmission

0:08

Morse code of "CQ DE PJ"

The cycle is very rapid, taking less than a millisecond. With each spark, this cycle produces a radio signal consisting of an oscillating sinusoidal wave that increases rapidly to a high amplitude and decreases exponentially to zero, called a damped wave.^[11] The frequency *f* of the oscillations, which is the frequency of the emitted radio waves, is equal to the resonant frequency of the resonant circuit, determined by the capacitance *C* of the capacitor and the inductance *L* of the coil:

$$f = \frac{1}{2\pi} \sqrt{\frac{1}{LC}}$$

The transmitter repeats this cycle rapidly, so the output is a repeating string of damped waves. This is equivalent to a radio signal amplitude modulated with a steady frequency, so it could be demodulated in a radio receiver by a rectifying AM detector, such as the crystal detector or Fleming valve used during the wireless telegraphy era. The frequency of repetition (spark rate) is in the audio range, typically 50 to 1000 sparks per second, so in a receiver's earphones the signal sounds like a steady tone, whine, or buzz.^[13]

In order to transmit information with this signal, the operator turns the transmitter on and off rapidly by tapping on a switch called a telegraph key in the primary circuit of the transformer, producing sequences of short (dot) and long (dash) strings of damped waves, to spell out messages in Morse code. As long as the key is pressed the spark gap fires repetitively, creating a string of pulses of radio waves, so in a receiver the keypress sounds like a buzz; the entire Morse code message sounds like a sequence of buzzes separated by pauses. In low-power transmitters the key directly breaks the primary circuit of the supply transformer, while in high-power transmitters the key operates a heavy duty relay that breaks the primary circuit.

Charging circuit and spark rate

The circuit which charges the capacitors, along with the spark gap itself, determines the *spark rate* of the transmitter, the number of sparks and resulting damped wave pulses it produces per second, which determines the tone of the signal heard in the receiver. The spark rate should not be confused with the *frequency* of the transmitter, which is the number of sinusoidal oscillations per second in each damped wave. Since the transmitter produces one pulse of radio waves per spark, the output power of the transmitter was proportional to the spark rate, so higher rates were favored. Spark transmitters generally used one of three types of power circuits:^{[11][13][17]:p.359–362}

Induction coil

An induction coil (Ruhmkorff coil) was used in low-power transmitters, usually less than 500 watts, often battery-powered. An induction coil is a type of transformer powered by DC, in which a vibrating arm switch contact on the coil called an interrupter repeatedly breaks the circuit that provides current to the primary winding, causing the coil to generate pulses of high voltage. When the primary current to the coil is turned on, the primary winding creates a magnetic field in the iron core which pulls the springy interrupter arm away from its contact, opening the switch and cutting off the primary current. Then the magnetic field collapses, creating a pulse of high voltage in the secondary winding, and the interrupter arm springs back to close the contact again, and the cycle repeats. Each pulse of high voltage charged up the capacitor until the spark gap fired, resulting in one spark per pulse. Interrupters were limited to low spark rates of 20–100 Hz, sounding like a low buzz in the receiver. In powerful induction coil transmitters, instead of a vibrating interrupter, a mercury turbine interrupter was used. This could break the current at rates up to several thousand hertz, and the rate could be adjusted to produce the best tone.

AC transformer

In higher power transmitters powered by AC, a transformer steps the input voltage up to the high voltage needed. The sinusoidal voltage from the transformer is applied directly to the capacitor, so the voltage on the capacitor varies from a high positive voltage, to zero, to a high negative voltage. The spark gap is adjusted so sparks only occur near the maximum voltage, at peaks of the AC sine wave, when the capacitor was fully charged. Since the AC sine wave has two peaks per cycle, ideally two sparks occurred during each cycle, so the spark rate was equal to twice the frequency of the AC power^[15] (often multiple sparks occurred during the peak of each half cycle). The spark rate of transmitters powered by 50 or 60 Hz mains power was thus 100 or 120 Hz. However higher audio frequencies cut through interference better, so in many transmitters the transformer was powered by a motor–alternator set, an electric motor with its shaft turning an alternator, that

produced AC at a higher frequency, usually 500 Hz, resulting in a spark rate of 1000 Hz.^[15]

Quenched spark gap

The speed at which signals may be transmitted is naturally limited by the time taken for the spark to be extinguished. If, as described above, the conductive plasma does not, during the zero points of the alternating current, cool enough to extinguish the spark, a 'persistent spark' is maintained until the stored energy is dissipated, permitting practical operation only up to around 60 signals per second. If active measures are taken to break the arc (either by blowing air through the spark or by lengthening the spark gap), a much shorter "quenched spark" may be obtained. A simple quenched spark system still permits several oscillations of the capacitor circuit in the time taken for the spark to be quenched. With the spark circuit broken, the transmission frequency is solely determined by the antenna resonant circuit, which permits simpler tuning.

Rotary spark gap

In a transmitter with a "rotary" spark gap (*below*), the capacitor was charged by AC from a high-voltage transformer as above, and discharged by a spark gap consisting of electrodes spaced around a wheel which was spun by an electric motor, which produced sparks as they passed by a stationary electrode.^{[11][15]} The spark rate was equal to the rotations per second times the number of spark electrodes on the wheel. It could produce spark rates up to several thousand hertz, and the rate could be adjusted by changing the speed of the motor. The rotation of the wheel was usually synchronized to the AC sine wave so the moving electrode passed by the stationary one at the peak of the sine wave, initiating the spark when the capacitor was fully charged, which produced a musical tone in the receiver. When tuned correctly in this manner, the need for external cooling or quenching airflow was eliminated, as was the loss of power directly from the charging circuit (parallel to the capacitor) through the spark.

History

The invention of the radio transmitter resulted from the convergence of two lines of research.

One was efforts by inventors to devise a system to transmit telegraph signals without wires. Experiments by a number of inventors had shown that electrical disturbances could be transmitted short distances through the air. However most of these systems worked not by radio waves but by electrostatic induction or electromagnetic induction, which had too short a range to be practical.^[18] In 1866 Mahlon Loomis claimed to have transmitted an electrical signal through the atmosphere between two 600 foot wires held aloft by kites on mountaintops 14 miles apart.^[18] Thomas Edison had come close to discovering radio in 1875; he had generated and detected radio waves which he called "etheric currents" experimenting with high-voltage spark circuits, but due to lack of time did not pursue the matter.^{[17]:p.259–261} David Edward Hughes in 1879 had also stumbled on radio wave transmission which he received with his carbon microphone detector, however he was persuaded that what he observed was induction.^{[17]:p.259–261} Neither of these individuals are usually credited with the discovery of radio, because they did not understand the significance of their observations and did not publish their work before Hertz.

The other was research by physicists to confirm the theory of electromagnetism proposed in 1864 by Scottish physicist James Clerk Maxwell, now called Maxwell's equations. Maxwell's theory predicted that a combination of oscillating electric and magnetic fields could travel through space as an "electromagnetic wave". Maxwell proposed that light consisted of electromagnetic waves of short wavelength, but no one knew how to confirm this, or generate or detect electromagnetic waves of other wavelengths. By 1883 it was theorized that accelerated electric charges could produce electromagnetic waves, and George Fitzgerald had calculated the output power of a loop antenna.^[19] Fitzgerald in a brief note published in 1883 suggested that electromagnetic waves could be generated practically by discharging a capacitor rapidly; the method used in spark transmitters,^{[20][21]} however there is no indication that this inspired other inventors.

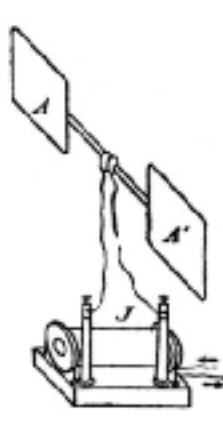
The division of the history of spark transmitters into the different types below follows the organization of the subject used in many wireless textbooks.^[22]

Hertzian oscillators

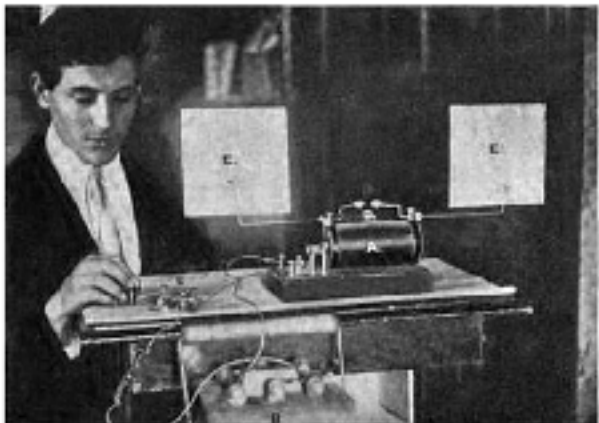
German physicist Heinrich Hertz in 1887 built the first experimental spark gap transmitters during his historic experiments to demonstrate the existence of electromagnetic waves predicted by James Clerk Maxwell in 1864, in which he discovered radio waves,^[23] ^{[24]:p.3-4[25][17]:p.19,260,331–332} which were called "Hertzian waves" until about 1910. Hertz was inspired to try spark excited circuits by experiments with "Reiss spirals", a pair of flat spiral inductors with their conductors ending in spark gaps. A Leyden jar capacitor discharged through one spiral, would cause sparks in the gap of the other spiral.



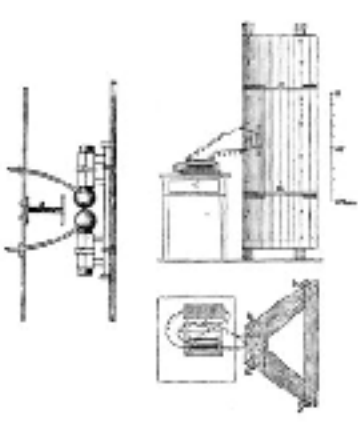
Heinrich Hertz discovering radio waves with his spark oscillator (*at rear*)



Hertz's drawing of one of his spark oscillators. (*A,A'*) antenna, (*J*) induction coil



Hertzian spark oscillator, 1902. Visible are antenna consisting of 2 wires ending in metal plates (*E*), spark gap (*D*), induction coil (*A*), auto battery (*B*), and telegraph key (*C*).



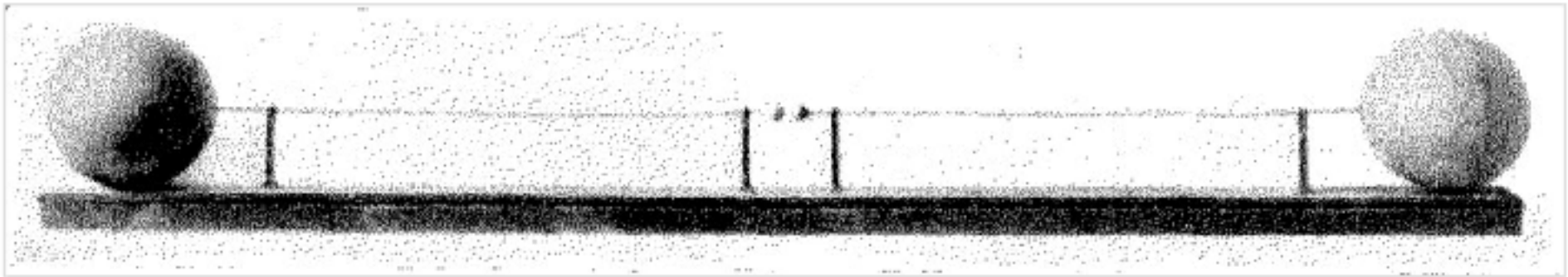
Hertz's 450 MHz transmitter; a 26 cm dipole with spark gap at focus of a sheet metal parabolic reflector



Jagadish Chandra Bose in 1894 was the first person to produce millimeter waves; his spark oscillator (*in box, right*) generated 60 GHz (5 mm) waves using 3 mm metal ball resonators.



Microwave spark oscillator demonstrated by Oliver Lodge in 1894. Its 5-inch resonator ball produced waves of around 12 cm or 2.5 GHz



Hertz's first oscillator: a pair of one meter copper wires with a 7.5 mm spark gap between them, ending in 30 cm zinc spheres. When 20,000 volt pulses from an induction coil (*not shown*) was applied, it produced waves at a frequency of roughly 50 MHz.

See circuit diagram. Hertz's transmitters consisted of a dipole antenna made of a pair of collinear metal rods of various lengths with a spark gap (S) between their inner ends and metal balls or plates for capacitance (C) attached to the outer ends.^{[23][17]:p.19,260,331–332[25]} The two sides of the antenna were connected to an induction coil (Ruhmkorff coil) (T) a common lab power source which produced pulses of high voltage, 5 to 30 kV. In addition to radiating the waves, the antenna also acted as a harmonic oscillator (resonator) which generated the oscillating currents. High-voltage pulses from the induction coil (T) were applied between the two sides of the antenna. Each pulse stored electric charge in the capacitance of the antenna, which was immediately discharged by a spark across the spark gap. The spark excited brief oscillating standing waves of current between the sides of the antenna. The antenna radiated the energy as a momentary pulse of radio waves; a damped wave. The frequency of the waves was equal to the resonant frequency of the antenna, which was determined by its length; it acted as a half-wave dipole, which radiated waves roughly twice the length of the antenna (e.g. 15 MHz for 1 m, or 1.5 GHz for 1 cm). Hertz detected the waves by observing tiny sparks in micrometer spark gaps (M) in loops of wire which functioned as resonant receiving antennas. Oliver Lodge was also experimenting with spark oscillators at this time and came close to discovering radio waves before Hertz, but his focus was on waves on wires, not in free space.^{[26][17]:p.226}

Hertz and the first generation of physicists who built these "Hertzian oscillators", such as Jagadish Chandra Bose, Lord Rayleigh, George Fitzgerald, Frederick Trouton, Augusto Righi and Oliver Lodge, were mainly interested in radio waves as a scientific phenomenon, and largely failed to foresee its possibilities as a communication technology.^{[27]:p.54,98[24]:p.5-9,22[17]:p.260,263–265[28]} Due to the influence of Maxwell's theory, their thinking was dominated by the similarity between radio waves and light waves; they thought of radio waves as an invisible form of light.^{[24]:p.5-9,22[17]:p.260,263–265} By analogy with light, they assumed that radio waves only traveled in straight lines, so they thought radio transmission was limited by the visual horizon like existing optical signalling methods such as semaphore, and therefore was not capable of longer distance communication.^{[26][29][30]} As late as 1894 Oliver Lodge speculated that the maximum distance Hertzian waves could be transmitted was a half mile.^{[24]:p.5-9,22}

To investigate the similarity between radio waves and light waves, these researchers concentrated on producing short wavelength high-frequency waves with which they could duplicate classic optics experiments with radio waves, using quasioptical components such as prisms and lenses made of paraffin wax, sulfur, and pitch and wire diffraction gratings.^{[17]:p.476-484} Their short antennas generated radio waves in the VHF, UHF, or microwave bands. In his various experiments, Hertz produced waves with frequencies from 50 to 450 MHz, roughly the frequencies used today by broadcast television transmitters. Hertz used them to perform historic experiments demonstrating standing waves, refraction, diffraction, polarization and interference of radio waves.^{[31][17]:p.19,260,331–332} He also measured the speed of radio waves, showing they traveled at the same speed as light. These experiments established that light and radio waves were both forms of Maxwell's electromagnetic waves, differing only in frequency. Augusto Righi and Jagadish Chandra Bose around 1894 generated microwaves of 12 and 60 GHz respectively, using small metal balls as resonator-antennas.^{[32][17]:p.291-308}

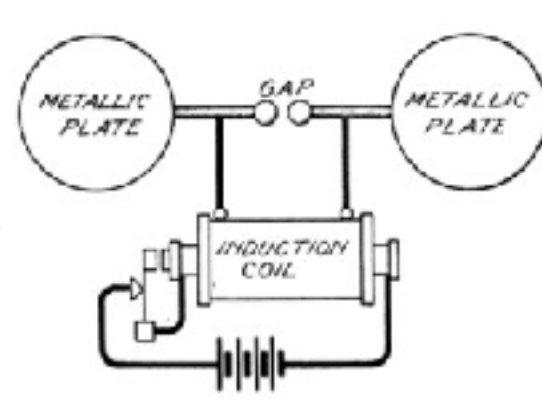
The high frequencies produced by Hertzian oscillators could not travel beyond the horizon. The dipole resonators also had low capacitance and couldn't store much charge, limiting their power output.^{[24]:p.5-9,22} Therefore, these devices were not capable of long distance transmission; their reception range with the primitive receivers employed was typically limited to roughly 100 yards (100 meters).^{[24]:p.5-9,22}

Non-syntonic transmitters

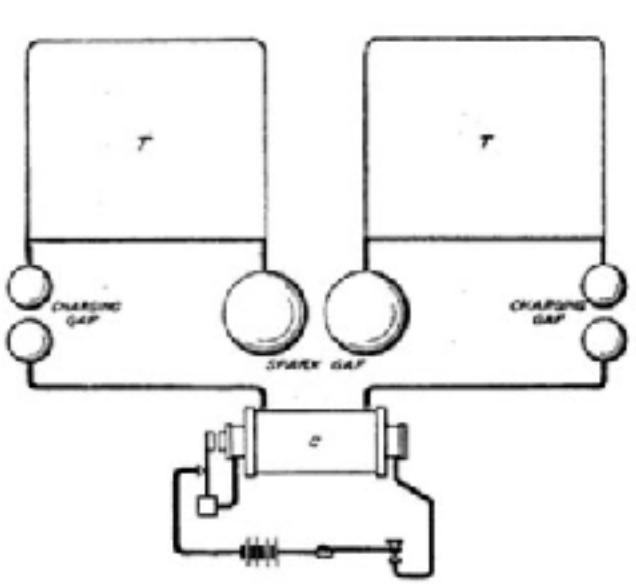
I could scarcely conceive it possible that [radio's] application to useful purposes could have escaped the notice of such eminent scientists.

—Guglielmo Marconi^[33]

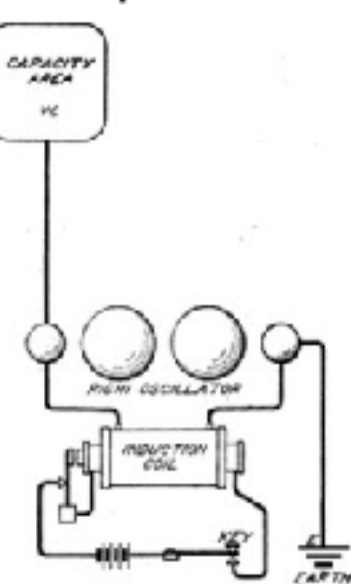
Italian radio pioneer Guglielmo Marconi was one of the first people to believe that radio waves could be used for long distance communication, and singlehandedly developed the first practical radiotelegraphy transmitters and receivers,^{[28][34][24]:ch.1&2} mainly by combining and tinkering with the inventions of others. Starting at age 21 on his family's estate in Italy, between 1894 and 1901 he conducted a long series of experiments to increase the transmission range of Hertz's spark oscillators and receivers.^[33]




Hertz's dipole oscillator



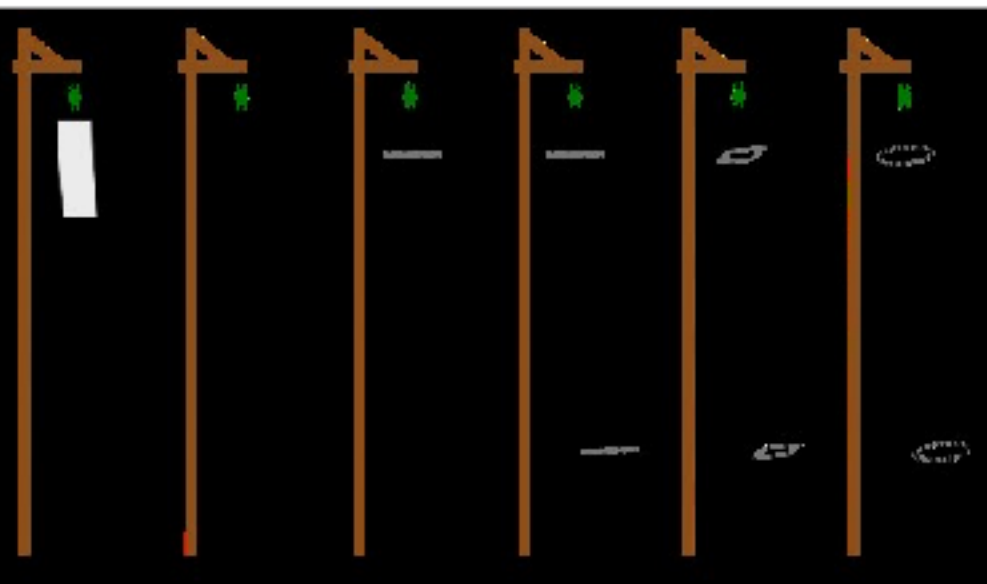
Marconi first tried enlarging the dipole antenna with 6x6 foot metal sheet "capacity areas" (t), 1895^[35] Metal sheets and spark balls not shown to scale.



Marconi's first monopole antenna transmitter, 1895. One side of spark gap grounded, the other attached to a metal plate (W).^[35]



Re-creation of Marconi's first monopole transmitter



Early vertical antennas. (A) Marconi found suspending the metal plate "capacity area" high above the ground increased range. (B) He found that a simple elevated wire worked just as well. (C-F) Later researchers found that multiple parallel wires were a better way to increase capacitance. "Cage antennas" (E-F) distributed current more equally between wires, reducing resistance

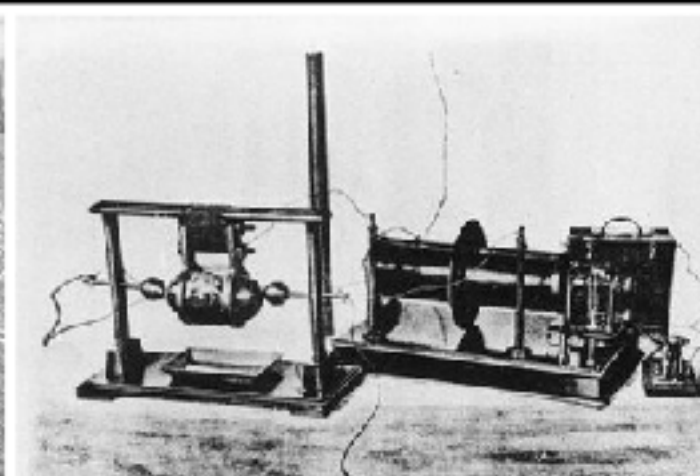
He was unable to communicate beyond a half-mile until 1895, when he discovered that the range of transmission could be increased greatly by replacing one side of the Hertzian dipole antenna in his transmitter and receiver with a connection to Earth and the other side with a long wire antenna suspended high above the ground.^{[24]:p.20-21[28][36]:195–218[37]} These antennas functioned as quarter-wave monopole antennas.^[38] The length of the antenna determined the wavelength of the waves produced and thus their frequency. Longer, lower frequency waves have less attenuation with distance.^[38] As Marconi tried longer antennas, which radiated lower frequency waves, probably in the MF band around 2 MHz,^[37] he found that he could transmit further.^[33] Another advantage was that these vertical antennas radiated vertically polarized waves, instead of the horizontally polarized waves produced by Hertz's horizontal antennas.^[39] These longer vertically polarized waves could travel beyond the horizon, because they propagated as a ground wave that followed the contour of the Earth. Under certain conditions they could also reach beyond the horizon by reflecting off layers of charged particles (ions) in the upper atmosphere, later called skywave propagation.^[30] Marconi did not understand any of this at the time; he simply found empirically that the higher his vertical antenna was suspended, the further it would transmit.



Marconi in 1901 with his early spark transmitter (*right*) and coherer receiver (*left*), which recorded the Morse code symbols with an ink line on a paper tape.



British Post Office officials examining Marconi's transmitter (*center*) and receiver (*bottom*) during a demonstration 1897. The pole supporting the vertical wire antenna is visible at center.



Marconi's transmitter in July 1897. (*left*) 4 ball Righi spark gap, (*right*) Induction coil, telegraph key, and battery box.



French non-syntonic transmitter used for ship-to-shore communication around 1900. It had a range of about 10 kilometres (6.2 mi).

After failing to interest the Italian government, in 1896 Marconi moved to England, where William Preece of the British General Post Office funded his experiments.^{[38][37][33]} Marconi patented his radio system 2 June 1896,^[35] often considered the first wireless patent.^{[17]:p.352-353,355-358[40]} In May 1897 he transmitted 14 km (8.7 miles),^[38] on 27 March 1899 he transmitted across the English Channel, 46 km (28 miles),^[33] in fall 1899 he extended the range to 136 km (85 miles),^{[24]:p.60-61} and by January 1901 he had reached 315 km (196 miles). These demonstrations of wireless Morse code communication at increasingly long distances convinced the world that radio, or "wireless telegraphy" as it was called, was not just a scientific curiosity but a commercially useful communication technology.

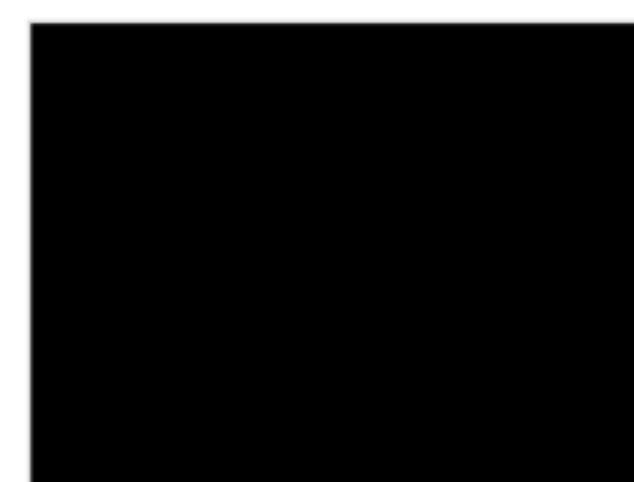
In 1897 Marconi started a company to produce his radio systems, which became the Marconi Wireless Telegraph Company.^{[38][33]} and radio communication began to be used commercially around 1900. His first large contract in 1901 was with the insurance firm Lloyd's of London to equip their ships with wireless stations. Marconi's company dominated marine radio throughout the spark era. Inspired by Marconi, in the late 1890s other researchers also began developing competing spark radio communication systems; Alexander Popov in Russia, Eugène Ducretet in France, Reginald Fessenden and Lee de Forest in America,^[1] and Karl Ferdinand Braun, Adolf Slaby, and Georg von Arco in Germany who in 1903 formed the Telefunken Co., Marconi's chief rival.^{[41][42]}

Disadvantages

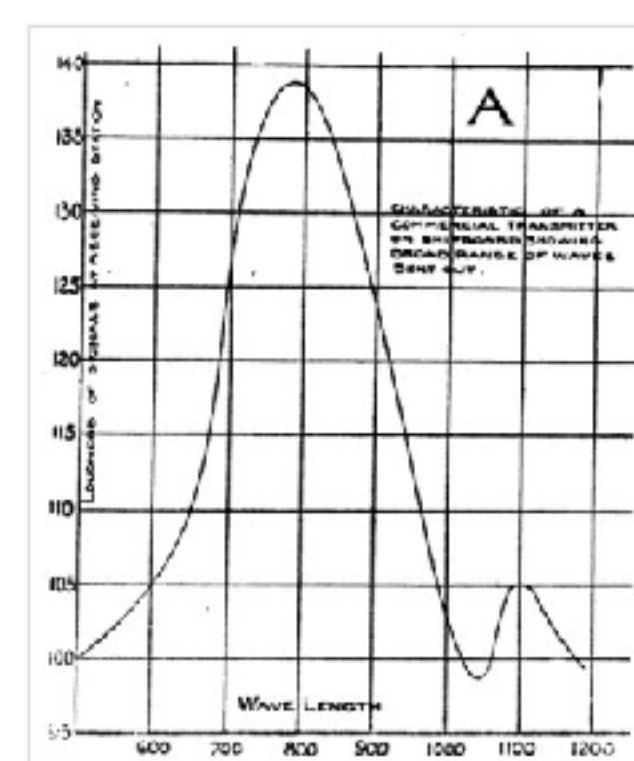
The primitive transmitters prior to 1897 had no resonant circuits (also called LC circuits, tank circuits, or tuned circuits), the spark gap was in the antenna, which functioned as the resonator to determine the frequency of the radio waves.^{[33][43][17]:p.352-353,355-358[44]} These were called "unsyntonized" or "plain antenna" transmitters.^{[17]:p.352-353,355-358[45]}

The average power output of these transmitters was low, because due to its low capacitance the antenna was a highly damped oscillator (in modern terminology, it had very low *Q* factor).^{[10]:p.4-7,32-33} During each spark the energy stored in the antenna was quickly radiated away as radio waves, so the oscillations decayed to zero quickly.^[46] The radio signal consisted of brief pulses of radio waves, repeating tens or at most a few hundreds of times per second, separated by comparatively long intervals of no output.^{[17]:p.352-353,355-358} The power radiated was dependent on how much electric charge could be stored in the antenna before each spark, which was proportional to the capacitance of the antenna. To increase their capacitance to ground, antennas were made with multiple parallel wires, often with capacitive toploads, in the "harp", "cage", "umbrella", "inverted-L", and "T" antennas characteristic of the "spark" era.^[47] The only other way to increase the energy stored in the antenna was to charge it up to very high voltages.^{[48][17]:p.352-353,355-358} However the voltage that could be used was limited to about 100 kV by corona discharge which caused charge to leak off the antenna, particularly in wet weather, and also energy lost as heat in the longer spark.

A more significant drawback of the large damping was that the radio transmissions were electrically "noisy"; they had a very large bandwidth.^{[11][24]:p.90-93[33][36]:72-75} These transmitters did not produce waves of a single frequency, but a continuous band of frequencies.^{[36]:72-75[24]:p.90-93} They were essentially radio noise sources radiating energy over a large part of the radio spectrum, which made it impossible for other transmitters to be heard.^[13] When multiple transmitters attempted to operate in the same area, their broad signals overlapped in frequency and interfered with each other.^{[33][44]} The radio receivers used also had no resonant circuits, so they had no way of selecting one signal from others besides the broad resonance of the antenna, and responded to the transmissions of all transmitters in the vicinity.^[44] An example of this interference problem was an embarrassing public debacle in August 1901 when Marconi, Lee de Forest, and G. W. Pickard attempted to report the New York Yacht Race to newspapers from ships with their untuned spark transmitters.^{[49][50][51]} The Morse code transmissions interfered, and the reporters on shore failed to receive any information from the garbled signals.



Circuit of Marconi's monopole transmitter and all other transmitters prior to 1897.



Emission bandwidth of a spark gap transmitter showing signal strength versus wavelength in meters

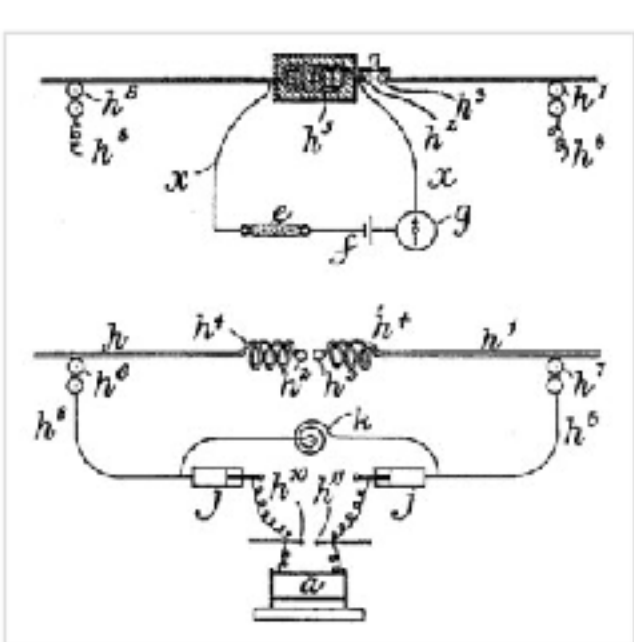
Syntonic transmitters

It became clear that for multiple transmitters to operate, some system of "selective signaling"^{[53][54]} had to be devised to allow a receiver to select which transmitter's signal to receive, and reject the others. In 1892 William Crookes had given an influential^[55] lecture^[56] on radio in which he suggested using resonance (then called *syntony*) to reduce the bandwidth of transmitters and receivers.^{[17]:p.352-353,355-358} Using a resonant circuit (also called tuned circuit or tank circuit) in transmitters would narrow the bandwidth of the radiated signal, it would occupy a smaller range of frequencies around its center frequency, so that the signals of transmitters "tuned" to transmit on different frequencies would no longer overlap. A receiver which had its own resonant circuit could receive a particular transmitter by "tuning" its resonant frequency to the frequency of the desired transmitter, analogously to the way one musical instrument could be tuned to resonance with another.^[53] This is the system used in all modern radio.

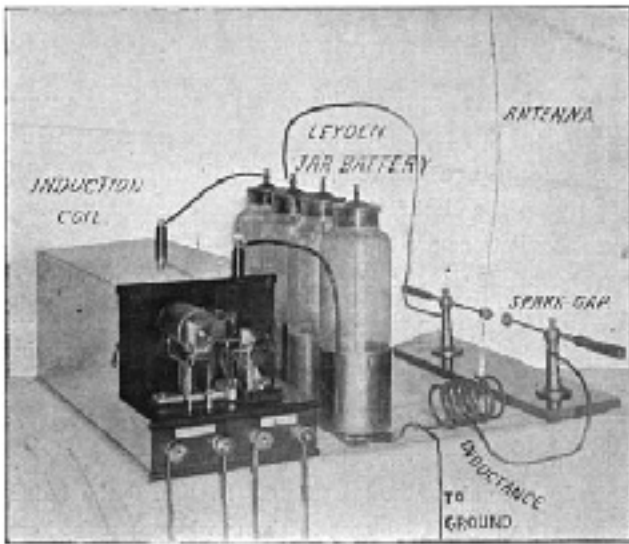
During the period 1897 to 1900 wireless researchers realized the advantages of "syntonic" or "tuned" systems, and added capacitors (Leyden jars) and inductors (coils of wire) to transmitters and receivers, to make resonant circuits (tuned circuits, or tank circuits).^{[36]:p. 125-136,254-255,259} Oliver Lodge, who had been researching electrical resonance for years,^{[36]:p.108-109[44]} patented the first "syntonic" transmitter and receiver in May 1897^{[52][57][26][36]:p.130-143} ^{[24]:p.90-93} Lodge added an inductor (coil)

between the sides of his dipole antennas, which resonated with the capacitance of the antenna to make a tuned circuit. [44][36]:p. 125-136,254-255,259 Although his complicated circuit did not see much practical use, Lodge's "syntonic" patent was important because it was the first to propose a radio transmitter and receiver containing resonant circuits which were tuned to resonance with each other. [44][36]:p. 125-136,254-255,259 In 1911 when the patent was renewed the Marconi Company was forced to buy it to protect its own syntonic system against infringement suits. [36]:p. 125-136,254-255,259

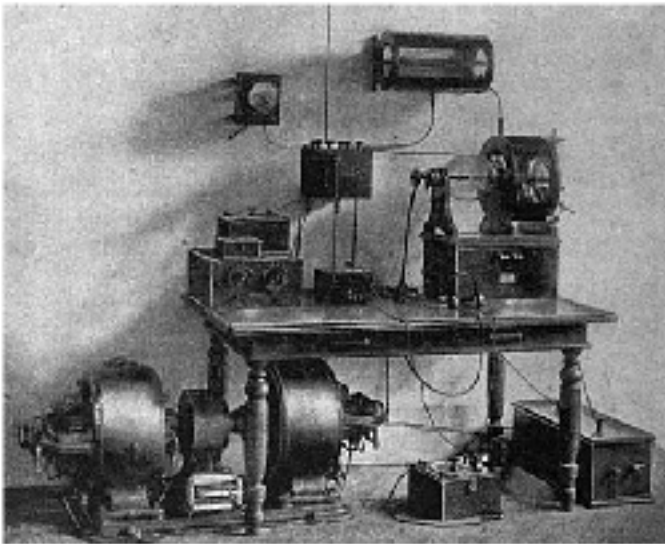
The resonant circuit functioned analogously to a tuning fork, storing oscillating electrical energy, increasing the Q factor of the circuit so the oscillations were less damped. [36]:p. 125-136,254-255,259 Another advantage was the frequency of the transmitter was no longer determined by the length of the antenna but by the resonant circuit, so it could easily be changed by adjustable taps on the coil. The antenna was brought into resonance with the tuned circuit using loading coils. The energy in each spark, and thus the power output, was no longer limited by the capacitance of the antenna but by the size of the capacitor in the resonant circuit. [17]:p.352-353,355-358 In order to increase the power very large capacitor banks were used. The form that the resonant circuit took in practical transmitters was the inductively-coupled circuit described in the next section.



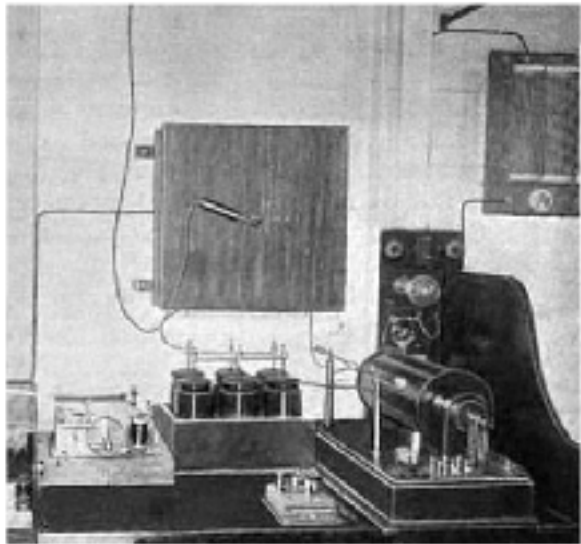
Transmitter (bottom) and receiver (top) of the first "syntonic" radio system, from Lodge's 1897 patent[52]



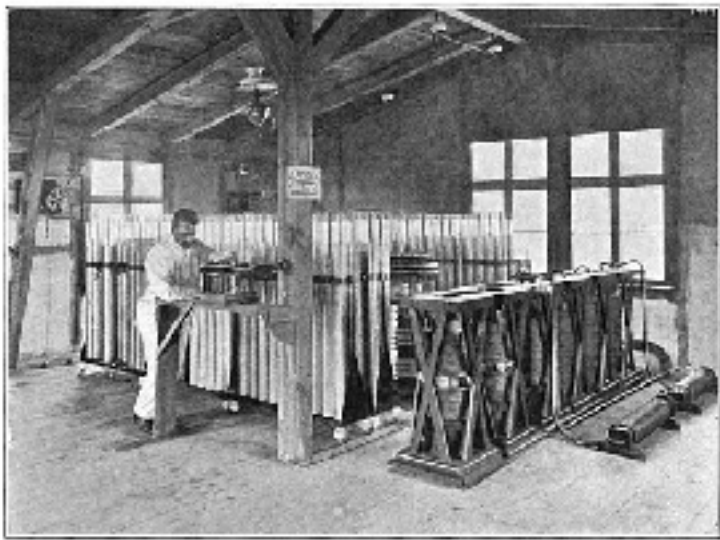
Demonstration inductively coupled spark transmitter 1909, with parts labeled



Amateur inductively coupled spark transmitter and receiver, 1910. The spark gap is in glass bulb (center right) next to tuning coil, on top of box containing glass plate capacitor



Standard Marconi inductively coupled transmitter on ship 1902. Spark gap is in front of induction coil, lower right. The spiral oscillation transformer is in the wooden box on the wall above the Leyden jars.



Telefunken 25 kW long distance transmitter built 1906 at Nauen Transmitter Station, Nauen, Germany, showing large 360 Leyden jar 400 μ F capacitor bank (rear) and vertical spark gaps (right)

Inductive coupling

In developing these syntonic transmitters, researchers found it impossible to achieve low damping with a single resonant circuit. A resonant circuit can only have low damping (high Q , narrow bandwidth) if it is a "closed" circuit, with no energy dissipating components. [58][24]:p.90-93[36]:p.108-109 But such a circuit does not produce radio waves. A resonant circuit with an antenna radiating radio waves (an "open" tuned circuit) loses energy quickly, giving it high damping (low Q , wide bandwidth). There was a fundamental tradeoff between a circuit which produced persistent oscillations which had narrow bandwidth, and one which radiated high power. [11]

The solution found by a number of researchers was to use two resonant circuits in the transmitter, with their coils inductively (magnetically) coupled, making a resonant transformer (called an *oscillation transformer*); [11][46][17]:p.352-353,355-358 this was called an "inductively coupled", "coupled circuit"[45] or "two circuit" transmitter. [33][48][24]:p.98-100 See circuit diagram. The primary winding of the oscillation transformer ($L1$) with the capacitor ($C1$) and spark gap (S) formed a "closed" resonant circuit, while the secondary winding ($L2$) was connected to the wire antenna (A) and ground, forming an "open" resonant circuit with the capacitance of the antenna ($C2$). [17]:p.352-353,355-358 Both circuits were tuned to the same resonant frequency. [17]:p.352-353,355-358 The advantage of the inductively coupled circuit was that the "loosely coupled" transformer transferred the oscillating energy of the tank circuit to the radiating antenna circuit gradually, creating long "ringing" waves. [46][11] A second advantage was that it allowed a large primary capacitance ($C1$) to be used which could store a lot of energy, increasing the power output enormously. [46][17]:p.352-353,355-358 Powerful transoceanic transmitters often had huge Leyden jar capacitor banks filling rooms (see pictures above). The receiver in most systems also used two inductively coupled circuits, with the antenna an "open" resonant circuit coupled through an oscillation transformer to a "closed" resonant circuit containing the detector. A radio system with a "two circuit" (inductively coupled) transmitter and receiver was called a "four circuit" system.

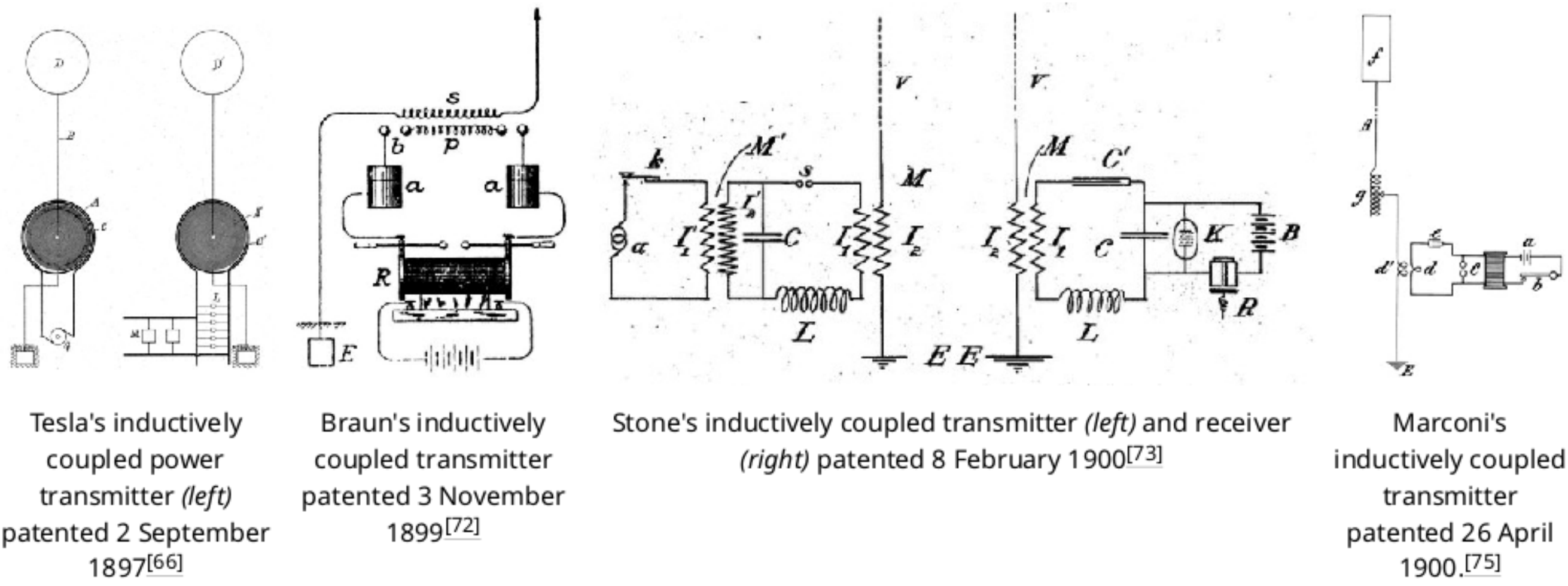


Inductively coupled spark transmitter. $C2$ is not an actual capacitor but represents the capacitance between the antenna A and ground.

The first person to use resonant circuits in a radio application was Nikola Tesla, who invented the resonant transformer in 1891. [59] At a March 1893 St. Louis lecture [60] he had demonstrated a wireless system that, although it was intended for wireless power transmission, had many of the elements of later radio communication systems. [61][62][17]:p.352-353,355-358[36]:p. 125-136,254-255,259[63] A grounded capacitance-loaded spark-excited resonant transformer (his *Tesla coil*) attached to an elevated

wire monopole antenna transmitted radio waves, which were received across the room by a similar wire antenna attached to a receiver consisting of a second grounded resonant transformer tuned to the transmitter's frequency, which lighted a Geissler tube.^{[64][63][65]} This system, patented by Tesla 2 September 1897,^[66] 4 months after Lodge's "syntonic" patent, was in effect an inductively coupled radio transmitter and receiver, the first use of the "four circuit" system claimed by Marconi in his 1900 patent (*below*).^{[67][17]:p.352-353,355-358[63][61]} However, Tesla was mainly interested in wireless power and never developed a practical radio *communication* system.^{[68][69][64][17]:p.352-353,355-358}

In addition to Tesla's system, inductively coupled radio systems were patented by Oliver Lodge in February 1898,^{[70][71]} Karl Ferdinand Braun,^{[24]:p.98-100[17]:p.352-353,355-358[43][72]} in November 1899, and John Stone Stone in February 1900.^{[73][71]} Braun made the crucial discovery that low damping required "loose coupling" (reduced mutual inductance) between the primary and secondary coils.^{[74][17]:p.352-353,355-358}



Marconi at first paid little attention to syntony, but by 1900 developed a radio system incorporating features from these systems,^{[74][43]} with a two circuit transmitter and two circuit receiver, with all four circuits tuned to the same frequency, using a resonant transformer he called the "jigger".^{[58][33][24]:p.98-100} In spite of the above prior patents, Marconi in his 26 April 1900 "four circuit" or "master tuning" patent^[75] on his system claimed rights to the inductively coupled transmitter and receiver.^{[17]:p.352-353,355-358[71][63]} This was granted a British patent, but the US patent office twice rejected his patent as lacking originality. Then in a 1904 appeal a new patent commissioner reversed the decision and granted the patent,^{[76][63]} on the narrow grounds that Marconi's patent by including an antenna loading coil (*J in circuit above*) provided the means for tuning the four circuits to the same frequency, whereas in the Tesla and Stone patents this was done by adjusting the length of the antenna.^{[71][63]} This patent gave Marconi a near monopoly of syntonic wireless telegraphy in England and America.^{[77][33]} Tesla sued Marconi's company for patent infringement but didn't have the resources to pursue the action. In 1943 the US Supreme Court invalidated the inductive coupling claims of Marconi's patent^[78] due to the prior patents of Lodge, Tesla, and Stone, but this came long after spark transmitters had become obsolete.^{[71][63]}

The inductively coupled or "syntonic" spark transmitter was the first type that could communicate at intercontinental distances, and also the first that had sufficiently narrow bandwidth that interference between transmitters was reduced to a tolerable level. It became the dominant type used during the "spark" era.^[33] A drawback of the plain inductively coupled transmitter was that unless the primary and secondary coils were very loosely coupled it radiated on two frequencies.^{[17]:p.352-353,355-358[79]} This was remedied by the quenched-spark and rotary gap transmitters (*below*).

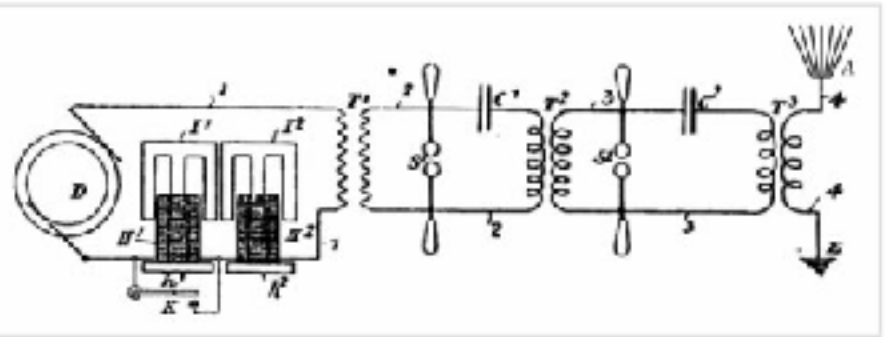
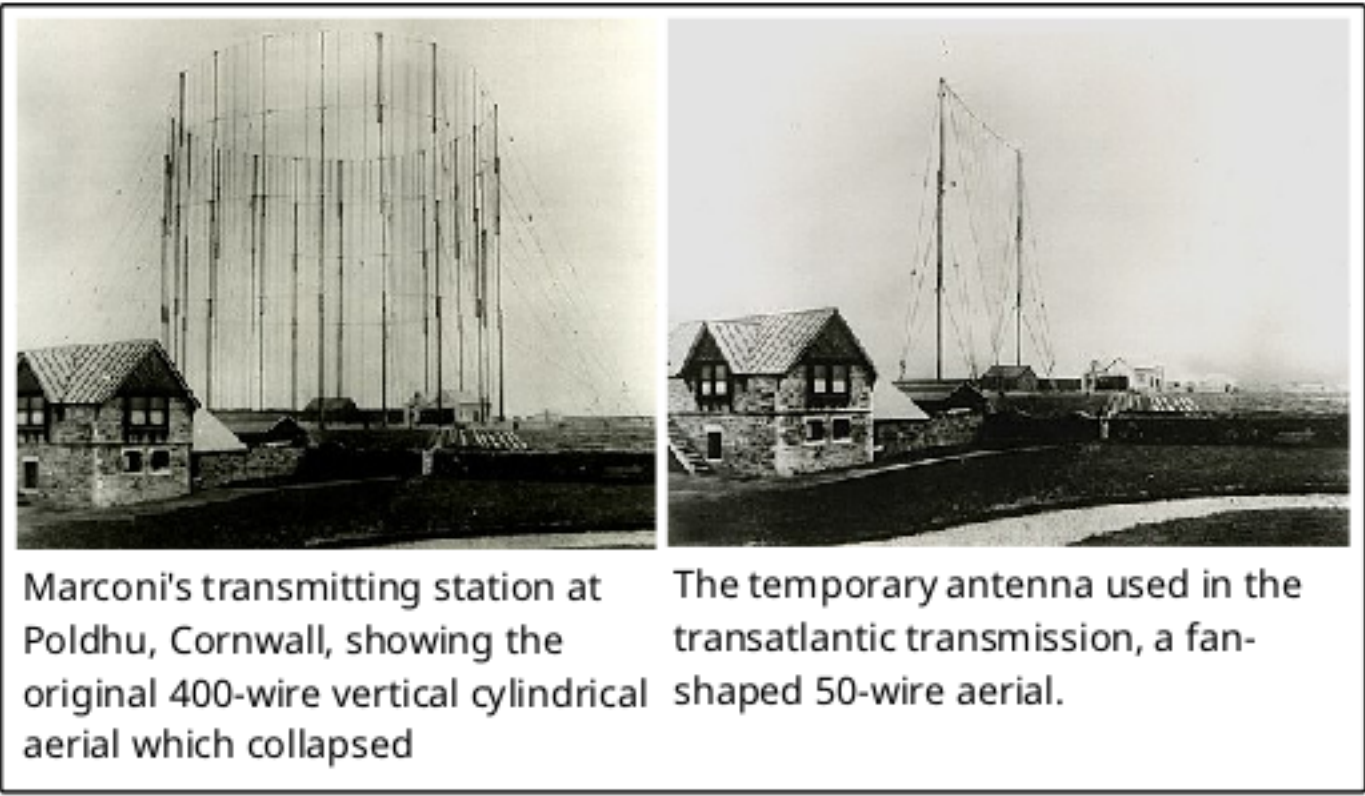
In recognition of their achievements in radio, Marconi and Braun shared the 1909 Nobel Prize in physics.^{[17]:p.352-353,355-358}

First transatlantic radio transmission

Marconi decided in 1900 to attempt transatlantic communication, which would allow him to compete with submarine telegraph cables.^{[24]:p.60-61[17]:p.387-392} This would require a major scale-up in power, a risky gamble for his company. Up to that time his small induction coil transmitters had an input power of 100 - 200 watts, and the maximum range achieved was around 150 miles.^{[24]:p.60-61[80]} To build the first high power transmitter, Marconi hired an expert in electric power engineering, Prof. John Ambrose Fleming of University College, London, who applied power engineering principles. Fleming designed a complicated inductively-coupled transmitter (*see circuit*) with two cascaded spark gaps (*S1, S2*) firing at different rates, and three resonant circuits, powered by a 25 kW alternator (*D*) turned by a combustion engine.^{[80][24]:p.60-61[81]} The first spark gap and resonant circuit (*S1, C1, T2*) generated the high voltage to charge the capacitor (*C2*) powering the second spark gap and resonant circuit (*S2, C2, T3*), which generated the output.^[81] The spark rate was low, perhaps as low as 2 - 3 sparks per second.^[81] Fleming estimated the radiated power was around 10 - 12 kW.^[80]

The transmitter was built in secrecy on the coast at Poldhu, Cornwall, UK.^{[80][24]:p.60-61} Marconi was pressed for time because Nikola Tesla was building his own transatlantic radiotelegraphy transmitter on Long Island, New York, in a bid to be first^{[24]:p.286-288} (this was the Wardenclyffe Tower, which lost funding and was abandoned unfinished after Marconi's success). Marconi's original round 400-wire transmitting antenna collapsed in a storm 17 September 1901 and he hastily erected a temporary antenna consisting of 50 wires suspended in a fan shape from a cable between two 160 foot poles.^{[80][81][24]:p.286-288} The frequency used is not known precisely, as Marconi did not measure wavelength or frequency, but it was between 166 and 984 kHz, probably around 500 kHz.^{[17]:p.387-392} He received the signal on the coast of St. John's, Newfoundland using an untuned coherer receiver with a 400 ft. wire antenna suspended from a kite.^{[17]:p.387-392[80][24]:p.286-288} Marconi announced the first transatlantic radio transmission took place on 12 December 1901, from Poldhu, Cornwall to Signal Hill, Newfoundland, a distance of 2100 miles (3400 km).^{[17]:p.387-392[24]:p.286-288}

Marconi's achievement received worldwide publicity, and was the final proof that radio was a practical communication technology. The scientific community at first doubted Marconi's report. Virtually all wireless experts besides Marconi believed that radio waves traveled in straight lines, so no one (including Marconi) understood how the waves had managed to propagate around the 300 mile high curve of the Earth between Britain and Newfoundland.^[30] In 1902 Arthur Kennelly and Oliver Heaviside independently theorized that radio waves were reflected by a layer of ionized atoms in the upper atmosphere, enabling them to return to Earth beyond the



Circuit of Poldhu transmitter.^[80] Fleming's curious dual spark gap design was not used in subsequent transmitters.

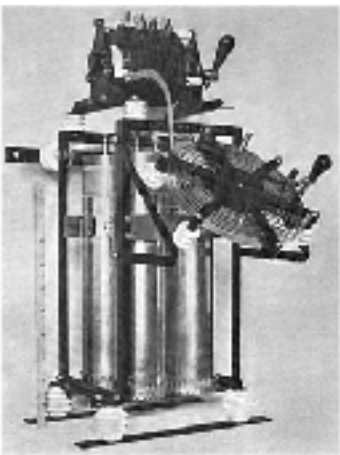
horizon.^[30] In 1924 Edward V. Appleton demonstrated the existence of this layer, now called the "Kennelly–Heaviside layer" or "E-layer", for which he received the 1947 Nobel Prize in Physics.

Knowledgeable sources today doubt whether Marconi actually received this transmission.^{[82][81][17]:p.387-392} Ionospheric conditions should not have allowed the signal to be received during the daytime at that range. Marconi knew the Morse code signal to be transmitted was the letter 'S' (three dots).^{[17]:p.387-392} He and his assistant could have mistaken atmospheric radio noise ("static") in their earphones for the clicks of the transmitter.^{[81][17]:p.387-392} Marconi made many subsequent transatlantic transmissions which clearly establish his priority, but reliable transatlantic communication was not achieved until 1907 with more powerful transmitters.^[81]

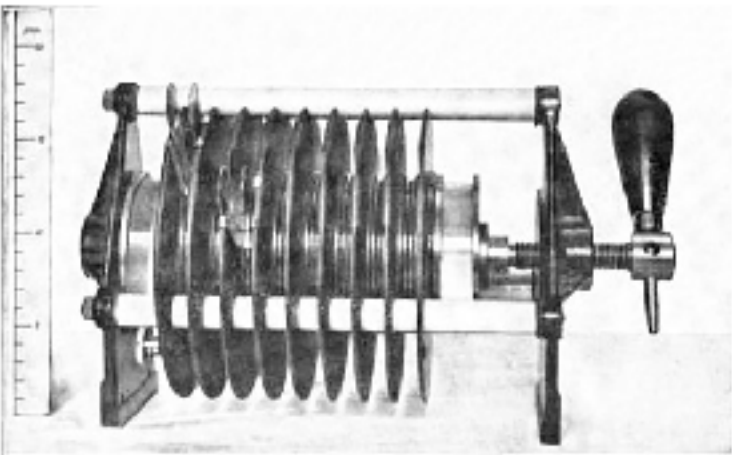
Quenched-spark transmitters



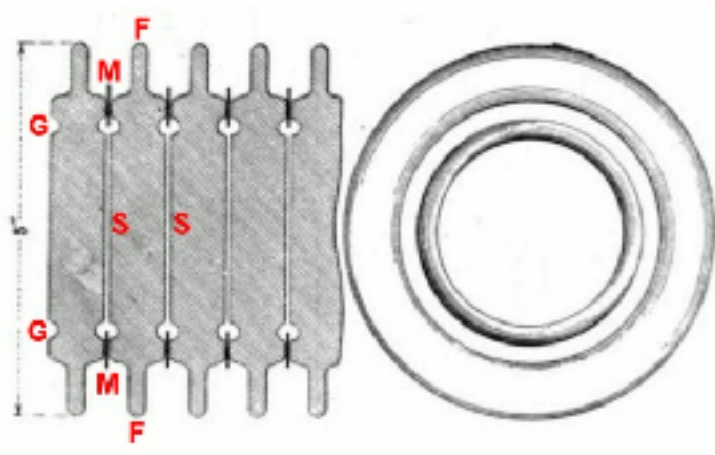
Ship radio room with 1.5 kW Telefunken quenched-spark transmitter



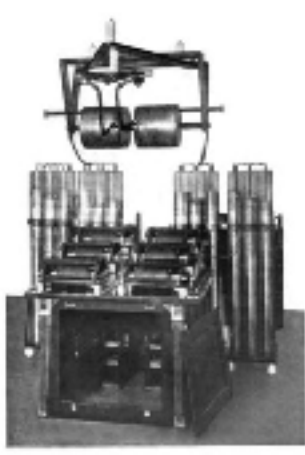
Tuned circuit of transmitter. (top) quenched gap, (center) oscillation transformer, Leyden jars



Quenched spark gap from transmitter, left. The handle turns a screw which puts pressure on the stack of cylindrical electrodes, allowing the gap widths to be adjusted.



Cross section of portion of quenched spark gap, consisting of metal disks (F) separated by thin insulating mica washers (M) to make multiple microscopic spark gaps (S) in series



A powerful quenched-spark transmitter in Australia. The 6 cylinders in front of the Leyden jars are the quenched spark gaps.

The inductively-coupled transmitter had a more complicated output waveform than the non-syntonic transmitter, due to the interaction of the two resonant circuits. The two magnetically coupled tuned circuits acted as a coupled oscillator, producing beats (see top graphs). The oscillating radio frequency energy was passed rapidly back and forth between the primary and secondary resonant circuits as long as the spark continued.^{[84][79][85]} Each time the energy returned to the primary, some was lost as heat in the spark.^{[85][79]} In addition, unless the coupling was very loose the oscillations caused the transmitter to transmit on two separate frequencies.^{[79][86]} Since the narrow passband of the receiver's resonant circuit could only be tuned to one of these frequencies, the power radiated at the other frequency was wasted.

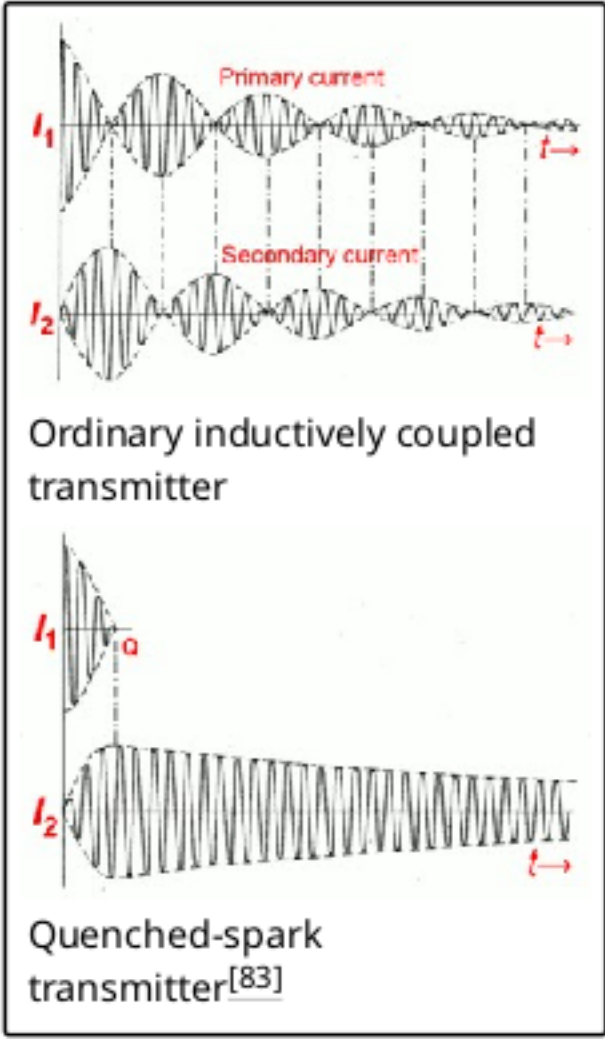
This troublesome backflow of energy to the primary circuit could be prevented by extinguishing (quenching) the spark at the right instant, after all the energy from the capacitors was transferred to the antenna circuit.^{[83][86]} Inventors tried various methods to accomplish this, such as air blasts and Elihu Thomson's magnetic blowout.^{[79][86]}

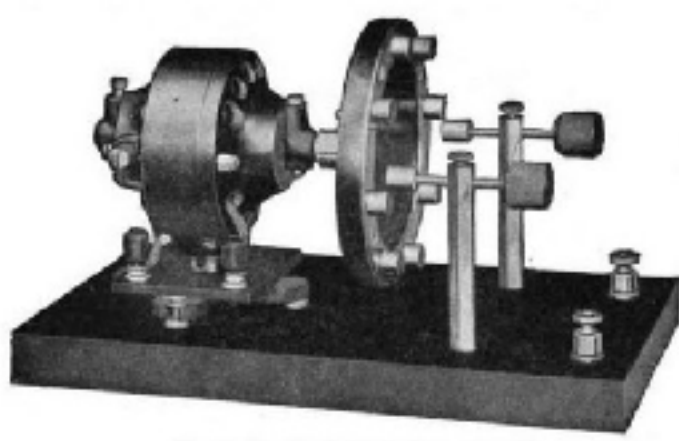
In 1906, a new type of spark gap was developed by German physicist Max Wien,^[87] called the series or quenched gap.^{[88][89][90][85]} A quenched gap consisted of a stack of wide cylindrical electrodes separated by thin insulating spacer rings to create many narrow spark gaps in series,^[89] of around 0.1–0.3 mm (0.004–0.01 in).^[88] The wide surface area of the electrodes terminated the ionization in the gap quickly by cooling it after the current stopped. In the inductively coupled transmitter, the narrow gaps extinguished ("quenched") the spark at the first nodal point (Q) when the primary current momentarily went to zero after all the energy had been transferred to the secondary winding (see lower graph).^[83] Since without the spark no current could flow in the primary circuit, this effectively uncoupled the secondary from the primary circuit, allowing the secondary resonant circuit and antenna to oscillate completely free of the primary circuit after that (until the next spark). This produced output power centered on a single frequency instead of two frequencies. It also eliminated most of the energy loss in the spark, producing very lightly damped, long "ringing" waves, with decrements of only 0.08 to 0.25^[91] (a Q of 12-38) and consequently a very "pure", narrow bandwidth radio signal. Another advantage was the rapid quenching allowed the time between sparks to be reduced, allowing higher spark rates of around 1000 Hz to be used, which had a musical tone in the receiver which penetrated radio static better. The quenched gap transmitter was called the "singing spark" system.^{[91][88]}

The German wireless giant Telefunken Co., Marconi's rival, acquired the patent rights and used the quenched spark gap in their transmitters.^{[90][88][85]}

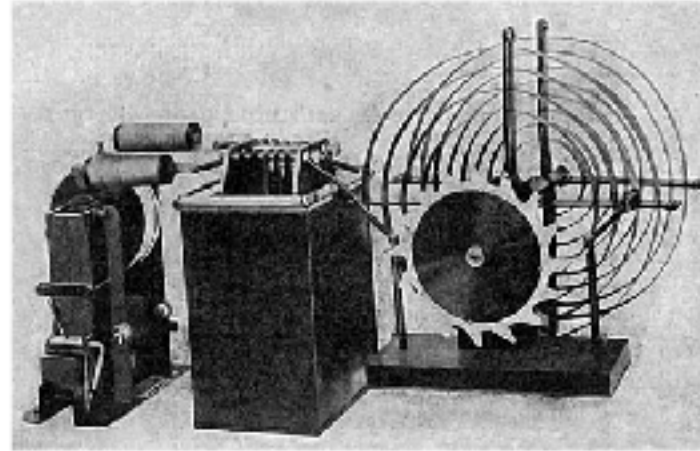
Rotary gap transmitters

A second type of spark gap that had a similar quenching effect^[15] was the "rotary gap", invented by Tesla in 1896^{[92][93]} and applied to radio transmitters by Reginald Fessenden and others.^{[17]:p.359–362[79]} It consisted of multiple electrodes equally spaced around a disk rotor spun at high speed by a motor, which created sparks as they passed by a stationary electrode.^{[11][48]} By using the correct motor speed, the rapidly separating electrodes extinguished the spark after the energy had been transferred to the secondary.^{[15][11][17]:p.359–362[79]} The rotating wheel also kept the electrodes cooler, important in high-power transmitters.

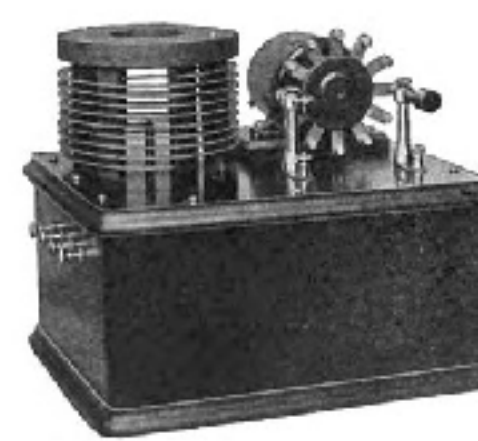




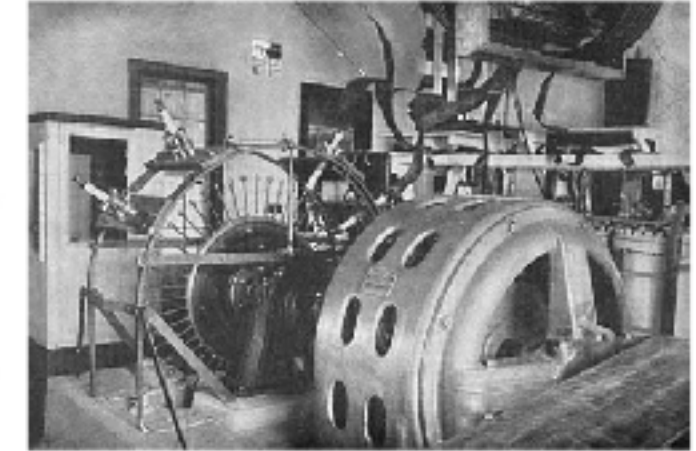
A typical rotary spark gap used in low-power transmitters



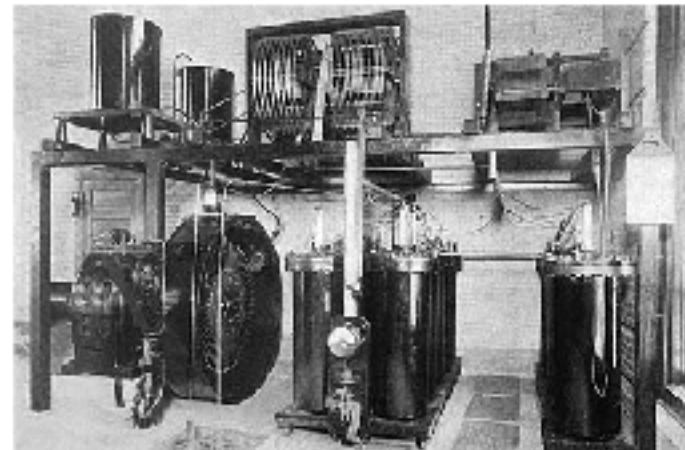
Small rotary spark transmitter, 1918



1 kilowatt rotary spark transmitter, 1914.



Fessenden's 35 kW synchronous rotary spark transmitter, built 1905 at Brant Rock, Massachusetts, with which he achieved the first 2 way transatlantic communication in 1906 on 88 kHz.



US Navy 100 kW rotary gap transmitter built by Fessenden in 1913 at Arlington, Virginia. It transmitted on 113 kHz to Europe, and broadcast the US's first radio time signal.

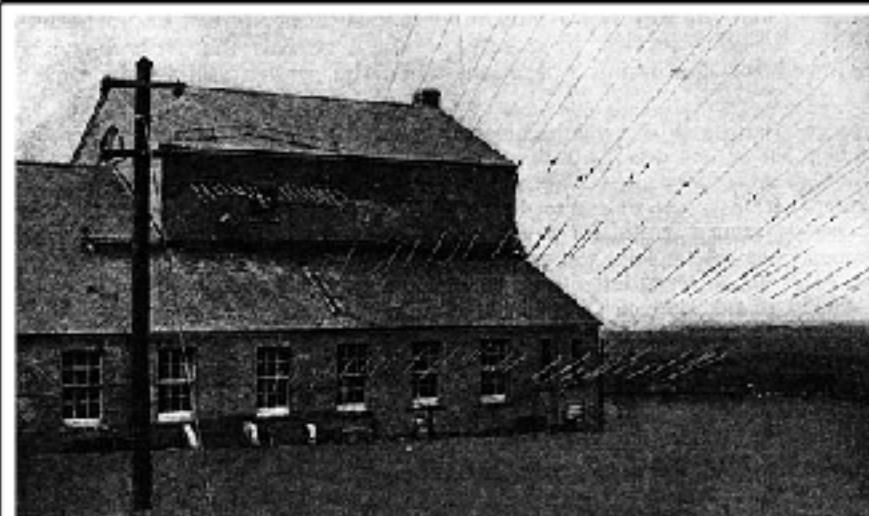
There were two types of rotary spark transmitter:^{[15][17]:p.359–362[11][79][81]}

- **Nonsynchronous:** In the earlier rotary gaps, the motor was not synchronized with the frequency of the AC transformer, so the spark occurred at random times in the AC cycle of the voltage applied to the capacitor. The problem with this was the interval between the sparks was not constant.^{[17]:p.359–362} The voltage on the capacitor when a moving electrode approached the stationary electrode varied randomly between zero and the peak AC voltage. The exact time when the spark started varied depending on the gap length the spark could jump, which depended on the voltage. The resulting random phase variation of successive damped waves resulted in a signal that had a "hissing" or "rasping" sound in the receiver.^[13]
- **Synchronous:** In this type, invented by Fessenden around 1904, the rotor was turned by a synchronous motor in synchronism with the cycles of the AC voltage to the transformer, so the spark occurred at the same points of the voltage sine wave each cycle. Usually it was designed so there was one spark each half cycle, adjusted so the spark occurred at the peak voltage when the capacitor was fully charged.^[13] Thus the spark had a steady frequency equal to a multiple of the AC line frequency, which created harmonics with the line frequency. The synchronous gap was said to produce a more musical, easily heard tone in the receiver, which cut through interference better.^[13]

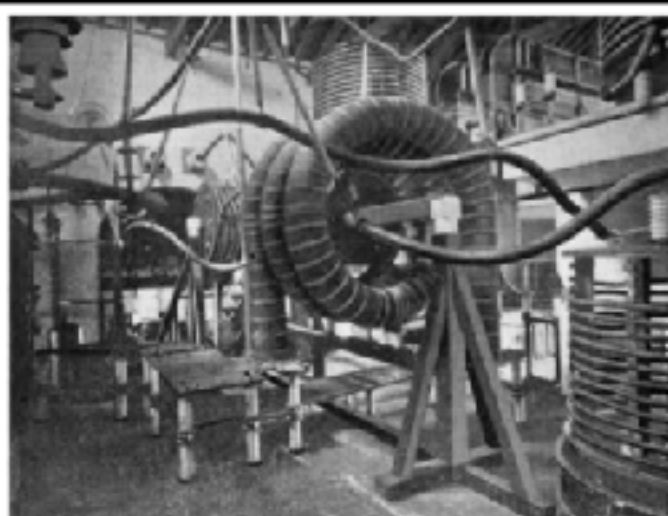
To reduce interference caused by the "noisy" signals of the burgeoning numbers of spark transmitters, the 1912 US Congress "Act to Regulate Radio Communication" required that "*the logarithmic decrement per oscillation in the wave trains emitted by the transmitter shall not exceed two tenths*"^{[48][11][94]} (this is equivalent to a Q factor of 15 or greater). Virtually the only spark transmitters which could satisfy this condition were the quenched-spark and rotary gap types above,^[48] and they dominated wireless telegraphy for the rest of the spark era.

Marconi's timed spark system

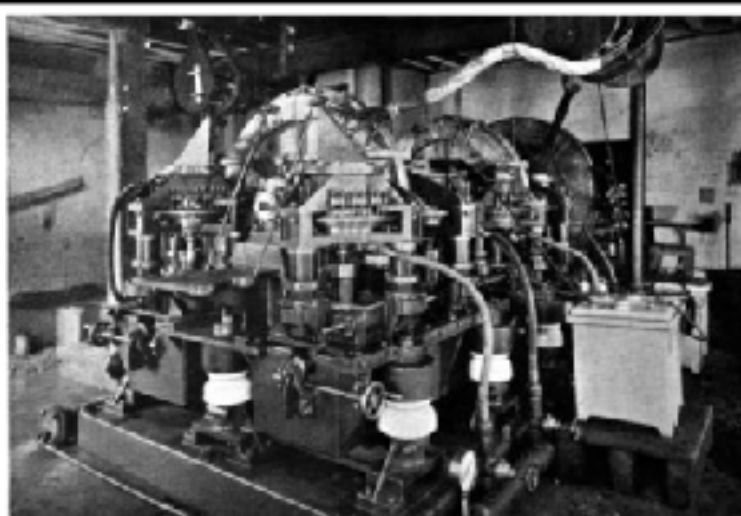
In 1912 in his high-power stations Marconi developed a refinement of the rotary discharger called the "timed spark" system, which generated what was probably the nearest to a continuous wave that sparks could produce.^{[95][96][17]:p.399} He used several identical resonant circuits in parallel, with the capacitors charged by a DC dynamo.^[97] These were discharged sequentially by multiple rotary discharger wheels on the same shaft to create overlapping damped waves shifted progressively in time, which were added together in the oscillation transformer so the output was a superposition of damped waves. The speed of the discharger wheel was controlled so that the time between sparks was equal to an integer multiple of the wave period. Therefore, oscillations of the successive wave trains were in phase and reinforced each other. The result was essentially a continuous sinusoidal wave, whose amplitude varied with a ripple at the spark rate. This system was necessary to give Marconi's transoceanic stations a narrow enough bandwidth that they didn't interfere with other transmitters on the narrow VLF band. Timed spark transmitters achieved the longest transmission range of any spark transmitters, but these behemoths represented the end of spark technology.^{[17]:p.399}



Transmitter building, showing the 36 feedlines feeding power to the 3,600 ft. flattop wire antenna.



5 ft diameter primary coil of oscillation transformer, consisting of 3 turns of specialized litz wire one foot thick



The three 5 ft rotary spark discharger wheels of the "timed spark" system.

Marconi 300 kW transatlantic timed spark transmitter built 1916 at Carnarvon, Wales, one of the most powerful spark transmitters ever built. During World War I it transmitted telegram traffic at 200 words per minute on 21.5 kHz to receivers in Belmar, New Jersey.^[98] The roar of the spark could reportedly be heard a kilometer away. On 22 September 1918 it transmitted the first wireless message from Britain to Australia, a distance of 15,200 km (9,439 miles).^[99] In 1921 it was replaced by Alexanderson alternator transmitters.

The "spark" era

The first application of radio was on ships, to keep in touch with shore, and send out a distress call if the ship were sinking.^[100] The Marconi Company built a string of shore stations and in 1904 established the first Morse code distress call, the letters *CQD*, used until the Second International Radiotelegraphic Convention in 1906 at which *SOS* was agreed on. The first significant marine rescue due to radiotelegraphy was the 23 January 1909 sinking of the luxury liner *RMS Republic*, in which 1500 people were saved.

Spark transmitters and the crystal receivers used to receive them were simple enough that they were widely built by hobbyists.^[15] During the first decades of the 20th century this exciting new high tech hobby attracted a growing community of "radio amateurs", many of them teenage boys, who used their homebuilt sets recreationally to contact distant amateurs and chat with them by Morse code, and relay messages.^{[102][103]} Low-power amateur transmitters ("squeak boxes") were often built with "trembler" ignition coils from early automobiles such as the Ford Model T.^[102] In the US prior to 1912 there was no government regulation of radio, and a chaotic "wild west" atmosphere prevailed, with stations transmitting without regard to other stations on their frequency, and deliberately interfering with each other.^{[104][105]} The expanding numbers of non-syntonic broadband spark transmitters created uncontrolled congestion in the airwaves, interfering with commercial and military wireless stations.^[105]

Radio frequencies used by spark transmitters during the wireless telegraphy era ^[101]			
Uses	Frequency (kilohertz)	Wavelength (meters)	Typical power range (kW)
Amateur	> 1500	< 200	0.25 - 0.5
Ships	500, 660, 1000	600, 450, 300	1 - 10
Navy	187.5 - 500	1600 - 600	5 - 20
Moderate size land stations	187.5 - 333	1600 - 900	5 - 20
Transoceanic stations	15 - 187.5	20,000 - 1600	20 - 500

The *RMS Titanic* sinking 14 April 1912 increased public appreciation for the role of radio, but the loss of life brought attention to the disorganized state of the new radio industry, and prompted regulation which corrected some abuses.^[103] Although the *Titanic* radio operator's *CQD* distress calls summoned the *RMS Carpathia* which rescued 705 survivors, the rescue operation was delayed four hours because the nearest ship, the *SS Californian*, only a few miles away, did not hear the *Titanic*'s call as its radio operator had gone to bed. This was held responsible for most of the 1500 deaths. Existing international regulations required all ships with more than 50 passengers to carry wireless equipment, but after the disaster subsequent regulations mandated ships have enough radio officers so that a round-the-clock radio watch could be kept. In the US 1912 Radio Act, licenses were required for all radio transmitters, maximum damping of transmitters was limited to a decrement of 0.2 to get old noisy non-syntonic transmitters off the air, and amateurs were mainly restricted to the unused frequencies above 1.5 MHz and output power of 1 kilowatt.^{[94][105][15]}

The largest spark transmitters were powerful transoceanic radiotelegraphy stations with input power of 100 - 300 kW.^{[106][107]} Beginning about 1910, industrial countries built global networks of these stations to exchange commercial and diplomatic telegram traffic with other countries and communicate with their overseas colonies.^{[108][109][110]} During World War I, radio became a strategic defensive technology, as it was realized a nation without long distance radiotelegraph stations could be isolated by an enemy cutting its submarine telegraph cables.^[109] Most of these networks were built by the two giant wireless corporations of the age: the British Marconi Company, which constructed the Imperial Wireless Chain to link the possessions of the British Empire, and the German Telefunken Co. which was dominant outside the British Empire.^[108] Marconi transmitters used the timed spark rotary discharger, while Telefunken transmitters used its quenched spark gap technology. Paper tape machines were used to transmit Morse code text at high speed. To achieve a maximum range of around 3000 – 6000 miles, transoceanic stations transmitted mainly in the very low frequency (VLF) band, from 50 kHz to as low as 15 – 20 kHz. At these wavelengths even the largest antennas were electrically short, a tiny fraction of a wavelength tall, and so had low radiation resistance (often below 1 ohm), so these transmitters required enormous wire umbrella and flattop antennas up to several miles long with large capacitive toploads, to achieve adequate efficiency. The antenna required a large loading coil at the base, 6 – 10 feet tall, to make it resonant with the transmitter.



Telefunken 100 kW transoceanic quenched spark transmitter at Nauen Transmitter Station, Nauen, Germany was the most powerful radio transmitter in the world when it was built in 1911

Continuous waves

Although their damping had been reduced as much as possible, spark transmitters still produced damped waves, which due to their large bandwidth caused interference between transmitters.^{[4][36]:p.72-79} The spark also made a very loud noise when operating, produced corrosive ozone gas, eroded the spark electrodes, and could be a fire hazard.^[15] Despite its drawbacks, most wireless experts believed along with Marconi that the impulsive "whipcrack" of a spark was necessary to produce radio waves that would communicate long distances.^{[17]:p.374[27]:p.78}

From the beginning, physicists knew that another type of waveform, continuous sinusoidal waves (CW), had theoretical advantages over damped waves for radio transmission.^{[111][10]:p.4-7,32-33} Because their energy is essentially concentrated at a single frequency, in addition to causing almost no interference to other transmitters on adjacent frequencies, continuous wave transmitters could transmit longer distances with a given output power.^{[36]:p.72-79} They could also be modulated with an audio signal to carry sound.^{[36]:p.72-79} The problem was no techniques were known for generating them. The efforts described above to reduce the damping of spark transmitters can be seen as attempts to make their output approach closer to the ideal of a continuous wave, but spark transmitters could not produce true continuous

Beginning about 1904, continuous wave transmitters were developed using new principles, which competed with spark transmitters. Continuous waves were first generated by two short-lived technologies:^[36]:p.72-79

- The arc converter (Poulsen arc) transmitter, invented by Valdemar Poulsen in 1904 used the negative resistance of a continuous electric arc in a hydrogen atmosphere to excite oscillations in a resonant circuit.
- The Alexanderson alternator transmitter, developed between 1906 and 1915 by Reginald Fessenden and Ernst Alexanderson, was a huge rotating alternating current generator (alternator) driven by an electric motor at a high enough speed that it produced radio frequency current in the very low frequency range.

These transmitters, which could produce power outputs of up to one megawatt, slowly replaced the spark transmitter in high-power radiotelegraphy stations. However spark transmitters remained popular in two way communication stations because most continuous wave transmitters were not capable of a mode called "break in" or "listen in" operation. With a spark transmitter, when the telegraph key was up between Morse symbols the carrier wave was turned off and the receiver was turned on, so the operator could listen for an incoming message. This allowed the receiving station, or a third station, to interrupt or "break in" to an ongoing transmission. In contrast, these early CW transmitters had to operate continuously; the carrier wave was not turned off between Morse code symbols, words, or sentences but just detuned, so a local receiver could not operate as long as the transmitter was powered up. Therefore, these stations could not receive messages until the transmitter was turned off.

Obsolescence

All these early technologies were superseded by the vacuum tube feedback electronic oscillator, invented in 1912 by Edwin Armstrong and Alexander Meissner, which used the triode vacuum tube invented in 1906 by Lee de Forest.^[1] Vacuum tube oscillators were a far cheaper source of continuous waves, and could be easily modulated to carry sound. Due to the development of the first high-power transmitting tubes by the end of World War I, in the 1920s tube transmitters replaced the arc converter and alternator transmitters, as well as the last of the old noisy spark transmitters.

The 1927 International Radiotelegraph Convention in Washington, D.C. saw a political battle to finally eliminate spark radio.^[6] Spark transmitters were long obsolete at this point, and broadcast radio audiences and aviation authorities were complaining of the disruption to radio reception that noisy legacy marine spark transmitters were causing. But shipping interests vigorously fought a blanket prohibition on damped waves, due to the capital expenditure that would be required to replace ancient spark equipment that was still being used on older ships. The Convention prohibited licensing of new land spark transmitters after 1929.^[112] Damped wave radio emission, called Class B, was banned after 1934 except for emergency use on ships.^[5]^[112] This loophole allowed shipowners to avoid replacing spark transmitters, which were kept as emergency backup transmitters on ships through World War II.

Legacy

One legacy of spark-gap transmitters is that radio operators were regularly nicknamed "Sparky" long after the devices ceased to be used. Even today, the German verb *funk**en*, literally, "to spark", also means "to send a radio message".

The spark gap oscillator was also used in nonradio applications, continuing long after it became obsolete in radio. In the form of the Tesla coil and Oudin coil it was used until the 1940s in the medical field of diathermy for deep body heating.^[113]^[114] High oscillating voltages of hundreds of thousands of volts at frequencies of 0.1 - 1 MHz from a Tesla coil were applied directly to the patient's body. The treatment was not painful, because currents in the radio frequency range do not cause the physiological reaction of electric shock. In 1926 William T. Bovie discovered that RF currents applied to a scalpel could cut and cauterize tissue in medical operations, and spark oscillators were used as electrosurgery generators or "Bovies" as late as the 1980s.^[115]

In the 1950s a Japanese toy company, Matsudaya, produced a line of cheap remote control toy trucks, boats and robots called Radicon, which used a low-power spark transmitter in the controller as an inexpensive way to produce the radio control signals.^[116]^[117] The signals were received in the toy by a coherer receiver.

Spark gap oscillators are still used to generate high-frequency high voltage needed to initiate welding arcs in gas tungsten arc welding.^[118] Powerful spark gap pulse generators are still used to simulate EMPs.

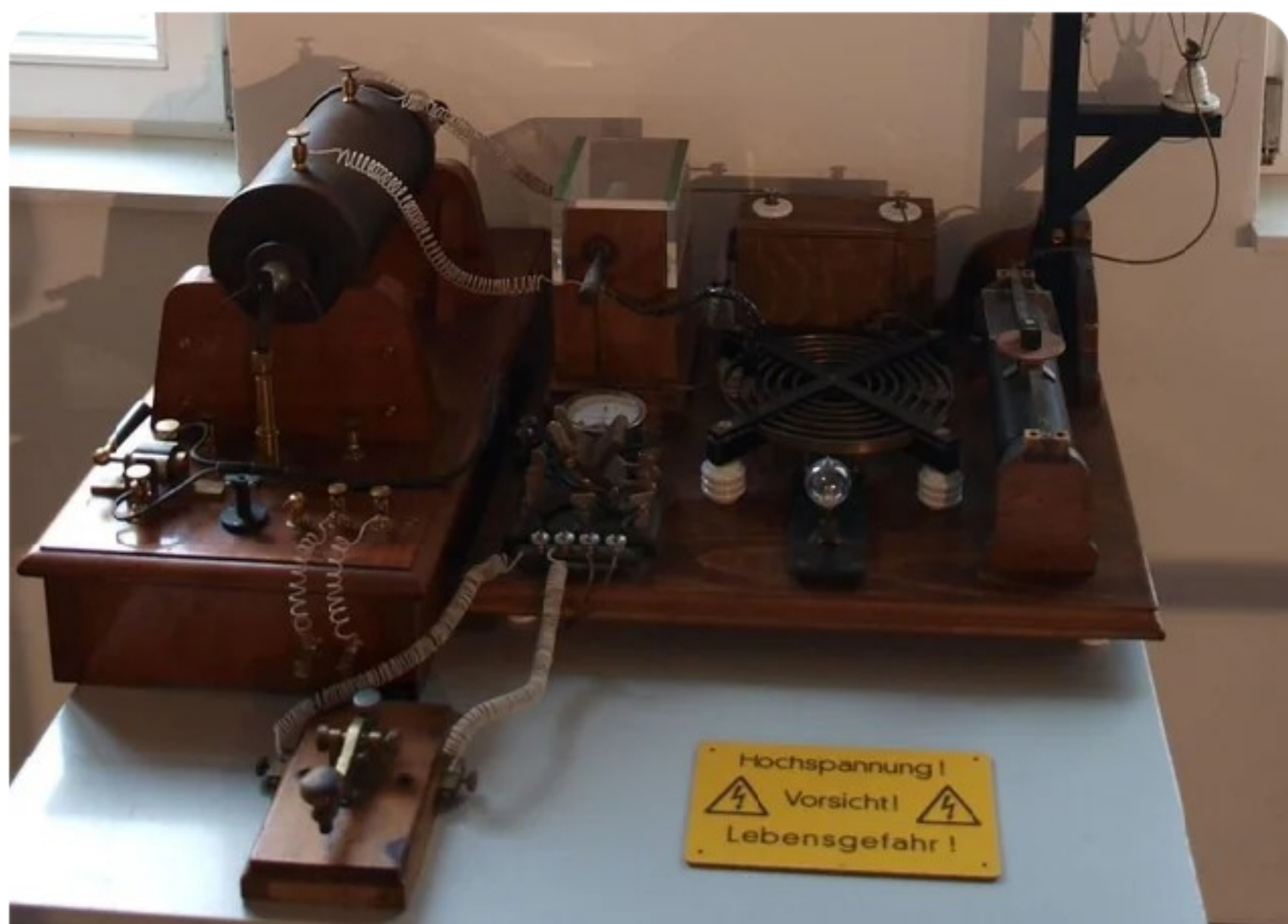
See also

- History of radio
- Invention of radio
- Amateur radio
- Antique radio
- Coherer
- Crystal radio

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Non-Syntonic Spark-Gap Transmitter
as radio jammer (illegal to turn it on,
not illegal to carry one around in a
backpack with the aerial disguised
as a sign or flag[the pole
specifically, but put a flag on it])
Description of what it does and how
in the link. Only use if you're about
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heavy is the induction coil. But if you get lithium battery packs it can be portable and have decent range capability. Otherwise, you can find an outlet and plug it in.

If you use it, be prepared to communicate with whistles, because it will nuke all radio transmissions within range. Whistles can't be jammed easily, so have a code in place to blow your whistles with important messages. Also, the spark gap transmitters can't do audio, only binary pulses, so you can use a pre-programmed Raspberry Pi to make it repeatedly send out protest slogans in morse code or whatever you like really. If you stuff it in a backpack, it needs a cooling fan, specifically for the spark gap and induction coil. Use a low voltage computer fan.

👍 6 🗨️ Reply 📄 Share



[deleted] • 3 mo. ago



[deleted] • 4 yr. ago



fraghawk • 3 yr. ago • Edited 3 yr. ago

Just stumbled across this post during a googling spree based on this same idea, good to see other like minded folk taking notice. I wonder about the practicality of constructing such a device in the modern era. My gut tells me that could be done on a significantly smaller scale than the pictures in the wiki article may suggest. One might get away with powering it with an old CRT flyback transformer, which are rather common in most industrialized parts of the world by now I would imagine. However the frequency response of such a transformer (~15khz) might complicate the design and requirements of the L C and R components of the circuitry (especially if it's using custom components) beyond what a more normal "audio rate" oscillation into the circuit would, but someone who knows the math than I do could easily calculate the needed values I would imagine. (I know 15 khz is audible but it is in effect 30khz, since the AC sine wave has two peaks per cycle, ideally two sparks occur during each cycle, so the spark rate should be equal to twice the frequency of the transformer output)

If corralled into a resonant circuit with lower damping, this turns into a simple CW radio that is more band limited, which might be useful for non mission critical communications or broadcasts over a large area, and the high frequency could be harnessed to cut through EMI better. If this is easy to make and the TX frequency can be changed easily, you now have a radio design that many people can use across different "channels" all at once.



wrong or misleading please correct me, I'm usually more of an audio guy but radio has long been a secondary interest of mine.

One last word, anyone who wants to mess with CRT flyback transformers or microwave transformers or any high voltage devices need to know the dangers of working with high voltage and that these components can and do kill people. A few safety tips for anyone who ants to work with electricity:

1. Work on un-energized circuits if at all possible. Always discharge capacitors before working.
2. Be very careful when working with 50hz/60hz mains electricity. It easily penetrates skin and contracts your muscles making you potentially grip a live object uncontrollably.
3. Limit the current and energy to the lowest values you can get away with. This will also keep cost of components down and make acquiring them easier in some situations.
4. Keep your distance from live high voltage circuits. Since high voltages can breakdown air to connect you to a circuit, you can be shocked at a distance. Keep in mind how far away an everyday static shock can bite you.
5. Be sure to properly ground your experiment and your enclosure. Take special care to safely de-energize and ground a circuit before working on it. Know when and how you can end up in the ground path in a circuit and put safeguards in place to eliminate this eventuality.
6. Never work alone, always have a partner who knows your equipment and the risks and hazards involved. That way, you have a second set of eyes to insure safety, and someone who can shut off the power and get help if you are injured.
7. Do not hold wires with both hands if at all possible. Electricity flowing between your arms can easily cross your heart which can easily kill even a healthy person with no heart problems.

Stay safe and try to have fun with it :) a person without an engineering degree can make all sorts of interesting useful equipment using easily available components from analog devices of eras past. Get good enough and you can make in hardware what people now use software for, great for those of us who are coding deficient.



2



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HauntingTurnovers • 2 mo. ago

Use back of the hand to touch. Not tight grip



1



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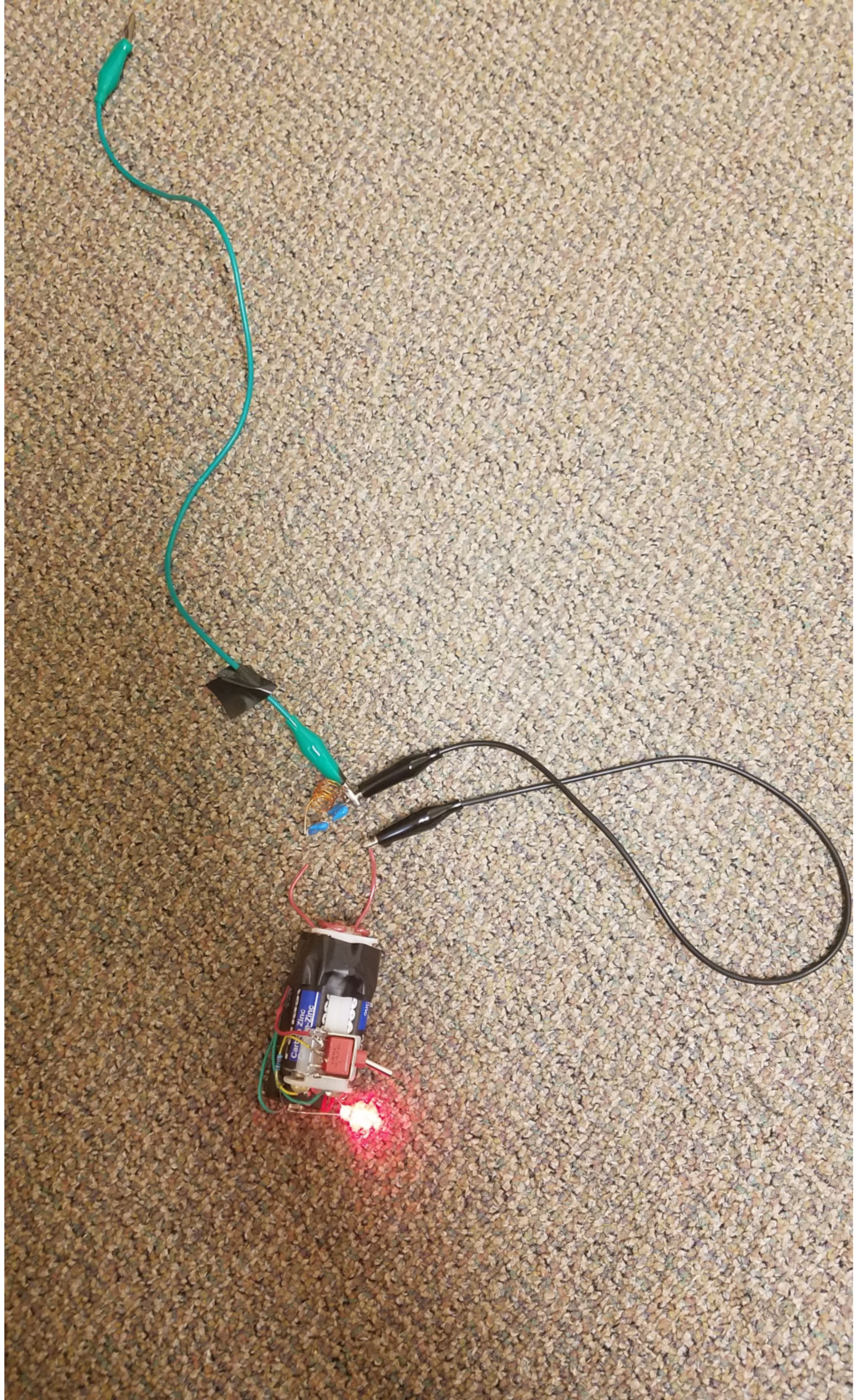
DIY Spark-Gap Radio Transmitter and Explanation

proteus-h⁽⁶¹⁾ ▾ (/@proteus-h)in #steemstem (/trending/steemstem) • 6 years ago (edited)

The first radio transmitters of the early 1900s were known as **spark-gap transmitters**. Spark-gap transmitters rely on a plasma arc from a high voltage supply to rapidly dump energy into a coil/antenna and produce radio-frequency oscillations, resulting in production of electromagnetic radiation. Spark-gap transmitters were used even before the advent of vacuum tube technology, and saw use as the sole radio transmission technology prior to World War I.

Spark-gap transmitters are also really easy to make, if you don't mind the final product being somewhat crude. That's what I've done today, and I'll be sharing how these devices work and how the (temporary) one I built performs.

As always, before getting into the details, here's what the final product looked like:





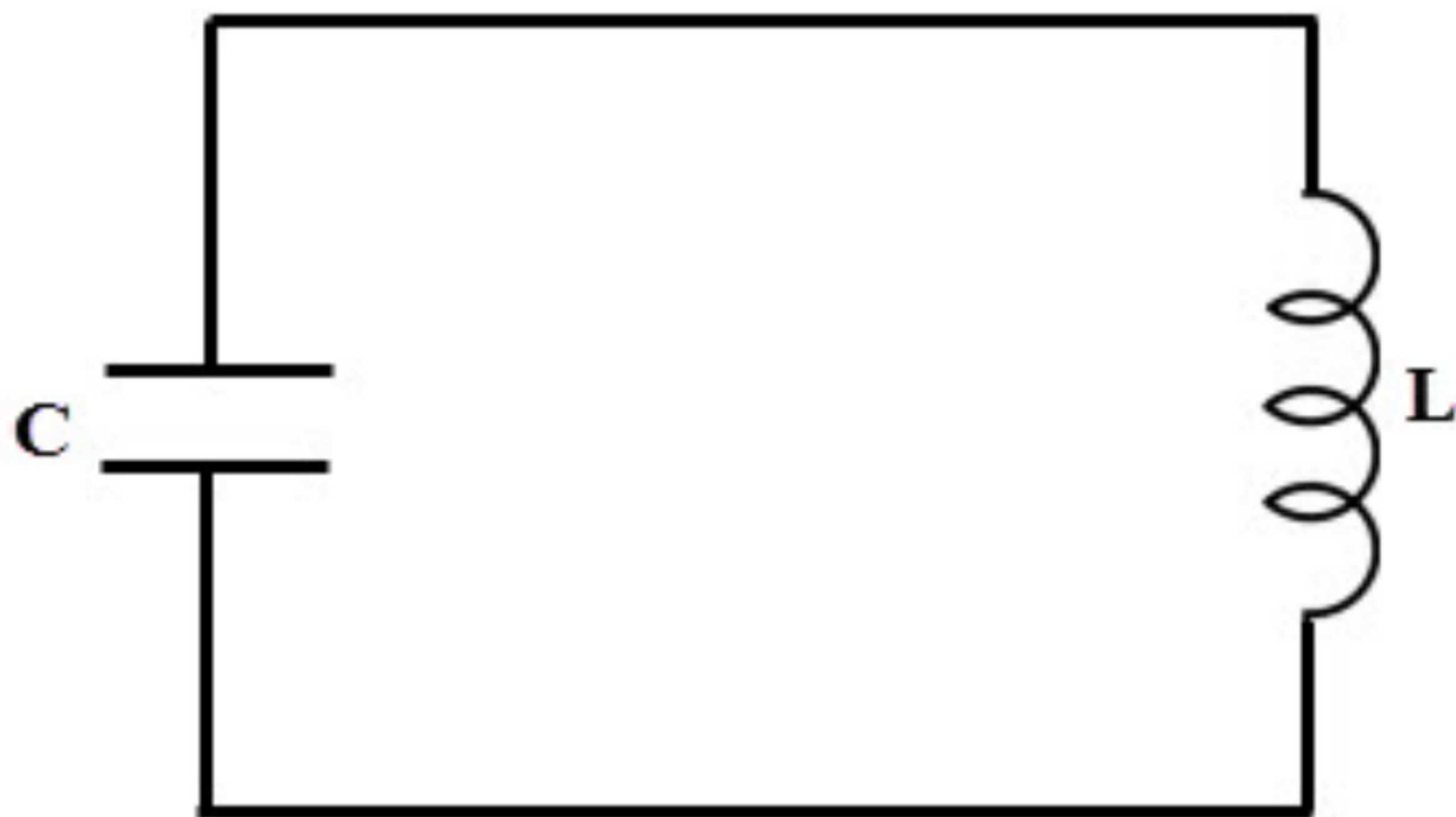
The green alligator wire serves as a crude antenna. Don't worry about the carpet... this HV supply can't even light paper on fire, let alone carpet ...

Spark-Gap Radio Transmitters: Principles of Operation

The core of a spark-gap transmitter is a high voltage supply. Several thousands of volts need to be produced to be able to produce an electric field strong enough to ionize air across a gap and produce the spark-gap itself. Anything over around 5,000 volts should work well. In this case, I'm using my mini stun gun I built a few days ago (writeup on it here (<https://steemit.com/gadgets/@proteus-h/mini-stun-gun-my-cheap-diy-high-voltage-box>)) to drive the oscillations that will produce electromagnetic waves.

But why is a spark-gap needed? Before getting to that, let's (again) talk about LC oscillators.

Connect a capacitor to an inductor and you have produced something called a LC circuit (L for inductance, C for capacitance). If the capacitor is charged when you connect it to the inductor, charge will rapidly oscillate back and forth between the inductor (storing energy in a magnetic field) and the capacitor (storing energy in an electric field). These oscillations occur, ideally, at a specific frequency determined only by the capacitance and inductance of the components used. In reality, resistance in the wire and various other mechanisms for energy loss cause the oscillation to quickly die out after a few oscillations. However, remember the electrical oscillations of charge produce electromagnetic waves: By attaching a somewhat decent antenna to an LC oscillator, we can radiate away electromagnetic waves of the same frequency as the LC oscillator.



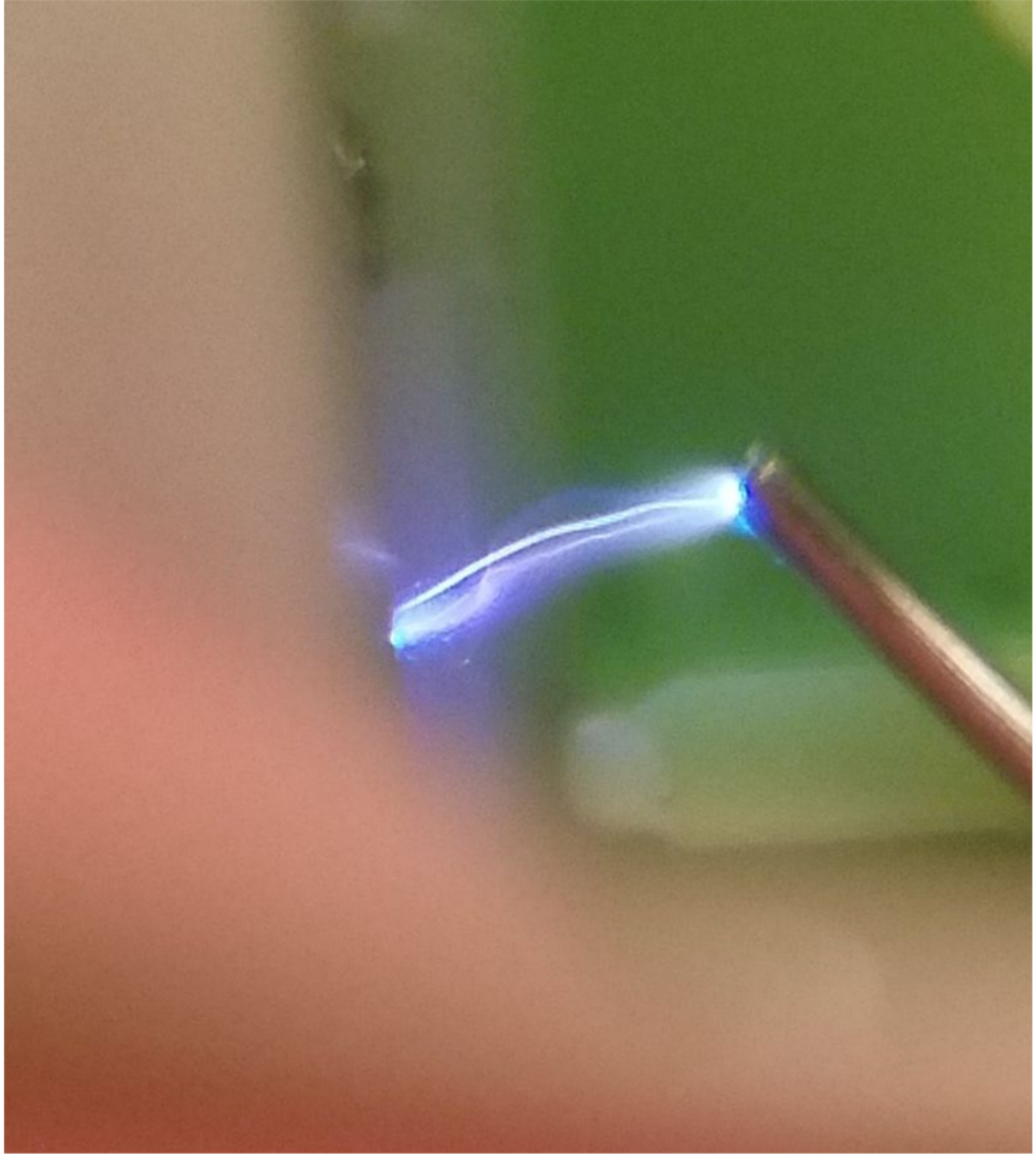
LC Tank Circuit

The most basic LC oscillator. If the capacitor starts charged, energy will move back and forth between the inductor and capacitor.

Credit 

So, the LC oscillator can produce radio waves for us, provided we use the correct components for the frequency we want and apply an antenna to the oscillator. But we need a way to power the oscillator: Simply applying a battery across the capacitor will bring the circuit to a steady-state with no oscillations, so that will not work. *This* is where the spark-gap comes into play.

Using a spark-gap completely bypasses the issue of powering the LC oscillator. A spark-gap is just a break in an electrical circuit with a small space between the broken wires. Since air is a very good insulator, no current flows and the circuit is open. However, apply a strong enough voltage across the gap, and the high electric field can ionize the air, resulting in an unstable plasma bridge forming across the gap. This plasma arc conducts electricity, so current flows across the gap, closing the circuit!



An example of a high voltage plasma arc, from one of my previous steemit posts. This one is produced by a piezoelectric crystal from a lighter. You know, on that note, I bet you could produce radio waves with this too ... maybe I'll try that someday.

But now that say our high-voltage source is a *capacitor* rather than a steady power supply. As capacitors discharge, their voltage drops. If a capacitor is connected across a spark-gap and ionizes the gap, the capacitor will discharge itself, dropping its voltage far below what was required to ignite the plasma arc as the plasma conducts current over the gap. However, the plasma can't last forever, and eventually the arc breaks up, once again

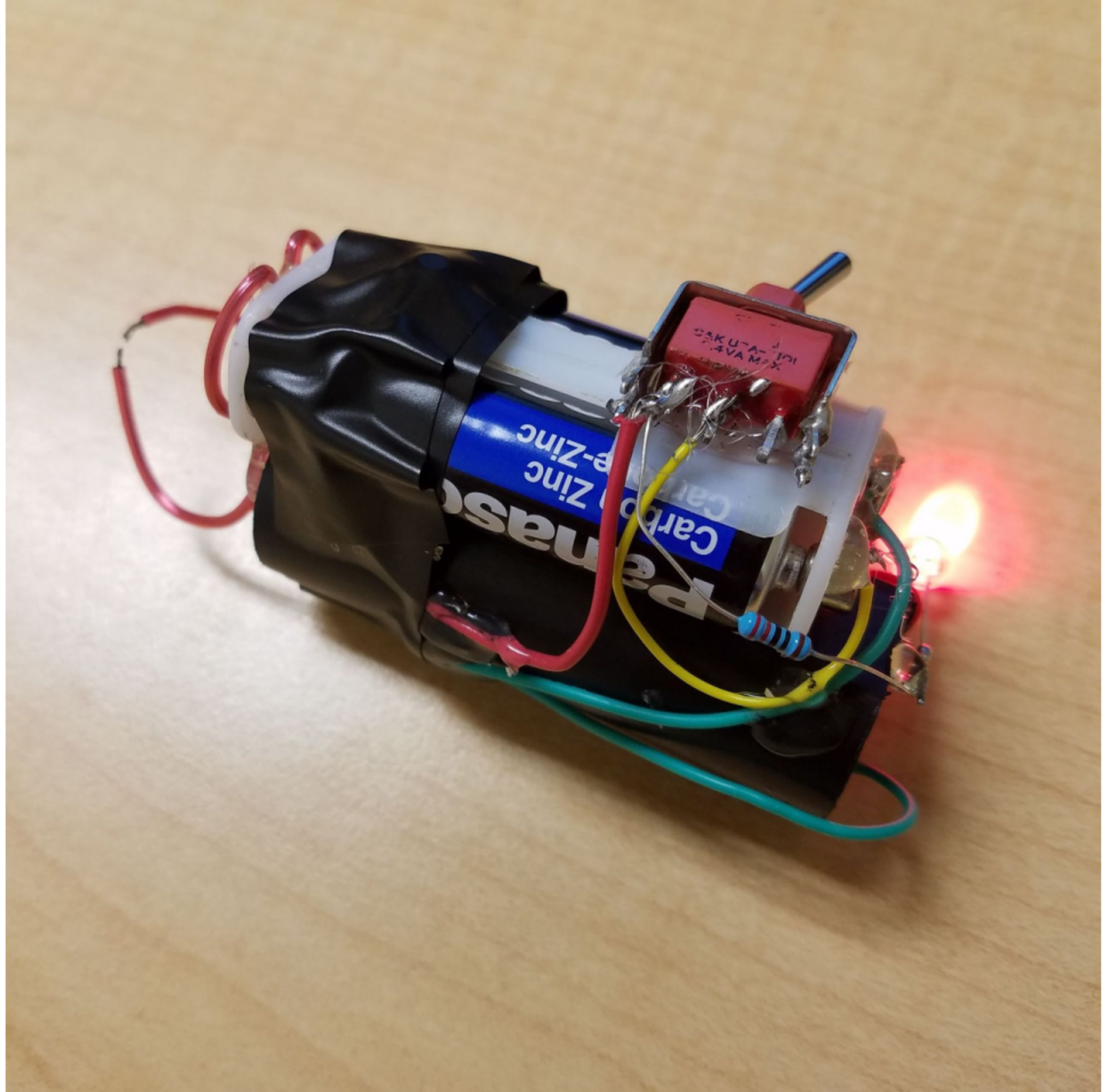
opening the circuit and stopping the flow of current. Now the capacitor is at a much lower voltage, and must charge back to the high voltage before the arc reforms. This means that the current arrives in spikes: Short momentary bursts of current followed by periods of no current at all.

This allows us to rapidly charge and discharge a LC oscillator circuit, letting the oscillator produce electromagnetic waves while the supply capacitor recharges.

In this idea, we have the basic spark-gap transmitter. A high voltage supply charges up a high voltage capacitor. When the voltage reaches a certain threshold, the air separating the supply circuit from a capacitor-inductor oscillator ionizes, sending a large pulse of current from the supply capacitor into the oscillator circuit. The plasma arc breaks, the supply capacitor recharges, and charge oscillations in the LC circuit radiate away electromagnetic waves via an antenna. These waves can then be detected at great distances by someone with a radio receiver, and allow you to send messages via morse code by doing nothing other than turning the circuit on and off: The first radio broadcasts.

My Spark-Gap Transmitter Demonstration

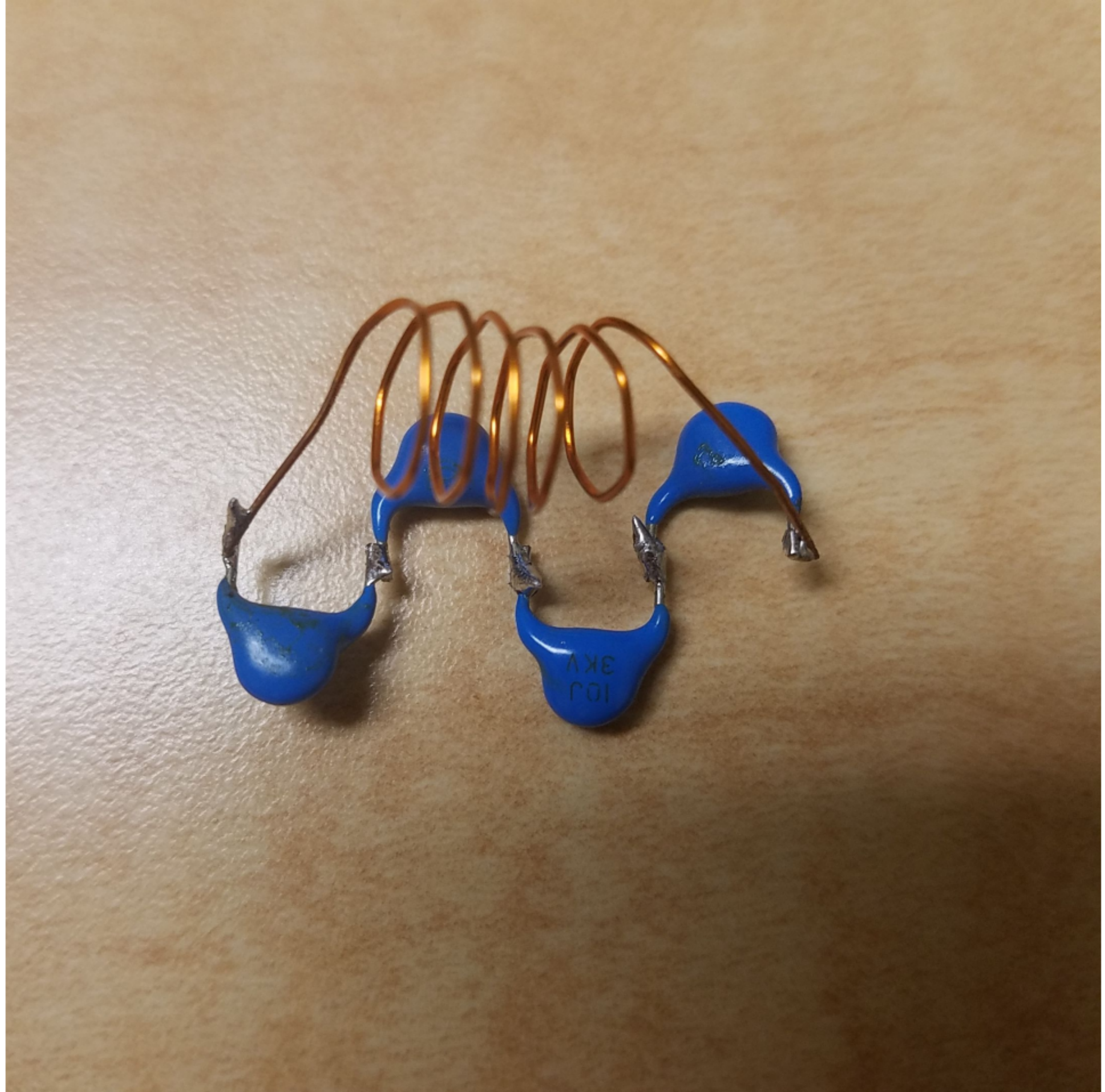
To build a quick spark-gap transmitter, I utilized my miniature high voltage supply I put together earlier this week (it's essentially a mini stun gun, and you can read about it on my profile). This produces no more than 10,000 volts, and easily produces a plasma arc across the leads at close distances. Since it likely uses a CW multiplier to boost the voltage, the high voltage supply has an output high voltage capacitor that acts as the final supply. This makes it perfect for use in a spark-gap transmitter (and, well, making a transmitter was one of the reasons I built the stun gun in the first place)



An image from my previous post - this is the high voltage supply I used for the transmitter.

For the LC oscillator portion of the transmitter, I used some high voltage capacitors in my junk box. These blue capacitors were salvaged from a CW multiplier last year that I believe was part of an old TV. Since each capacitor is only rated for 3,000 volts (3kV), I soldered four together in series. The result acts as a single capacitor with a capacitance somewhere around 1.5 pF and a voltage rating of 12 kV, more than enough to withstand anything the stun gun can put into it. For an inductor, I used a small coil of wire in the box that I tried to use with a crappy FM transmitter awhile back. It's not ideal, but hey, now I don't have to go buy stuff online for this.

Here's the oscillator circuit:



Homemade high voltage LC circuit. Ideally, when the capacitor bank is charged up, energy will oscillate between it and the crude inductor coil shown. This circuit should be able to handle upwards of 12 kV due to the capacitors being in series.

The hard part is, of course, the HV supply. With a source of high voltage arcs and a LC circuit, all that's left to do is hook everything up. I connected one lead of the HV stun gun to one end of the LC circuit, and connected an alligator clip wire to the oscillator portion to serve as a crude antenna. The second HV output lead is placed a few millimeters from the opposite end of the LC oscillator - this is the spark-gap.

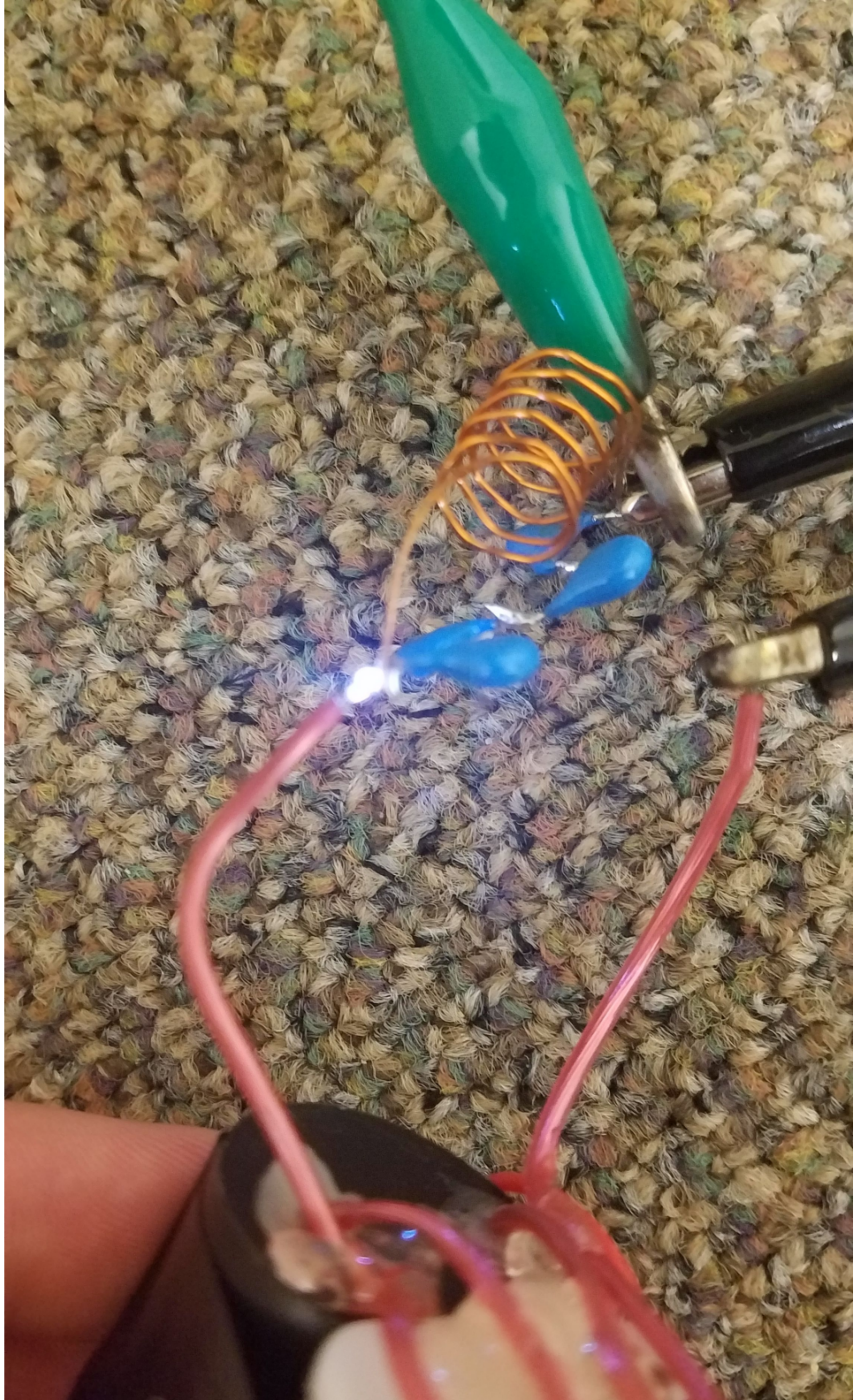
I'd like to point out that spark-gap transmitters can't produce very high frequency radiation due to limitations in the LC part of the circuit. ARRL [🔗](#)

quotes this as 30 kHz to 30 MHz, which puts spark-gap transmitters out of reach of the FM and UHF/VHF ham radio bands. This unfortunately makes my regular transceiver useless at picking up EM waves from my spark-gap transmitter. But, the typical AM band lies around the 1 MHz mark, and works extremely well for this experiment, so I used my AM/FM radio to try and detect electromagnetic pulses produced by the transmitter.



I used this radio to detect AM-band signals from the spark-gap transmitter. The long antenna helps pick up the extremely long ~ 1 MHz EM waves.

Anyway, all to do now is to fire up the circuit. This produces a small plasma arc (firing and closing several times per second) between the HV supply and the LC circuit. Here's an image of the transmitter in action, with the arc visible:





Spark-gap transmitter in action. Once again, the carpet is totally safe, as the fact that this high voltage is driven by a CW multiplier makes it extremely difficult to ignite things with it. The green clip leads to the "antenna", while the black clip leads back to the HV supply.

The results look good! Firing up the transmitter completely wipes out the radio receiver's ability to pick up a nearby AM radio station for at least 4-5 feet (my apartment is very good at blocking AM signals, so it was very difficult to test the transmitter much further than a few feet, as this required changing rooms which made it unclear whether the signals was being blocked by walls or the transmitter).

The signal is easily detected across the room, and likely farther away if I wasn't in this tiny room. Closer to the transmitter, you can actually hear the *cracks of the spark-gap* modulated into the signal on the radio receiver!

I did a few more tests to make sure the LC portion of the circuit was actually contributing in a meaningful way to the electromagnetic wave output. Without the green antenna wire, transmission range was negatively affected, *as expected*.

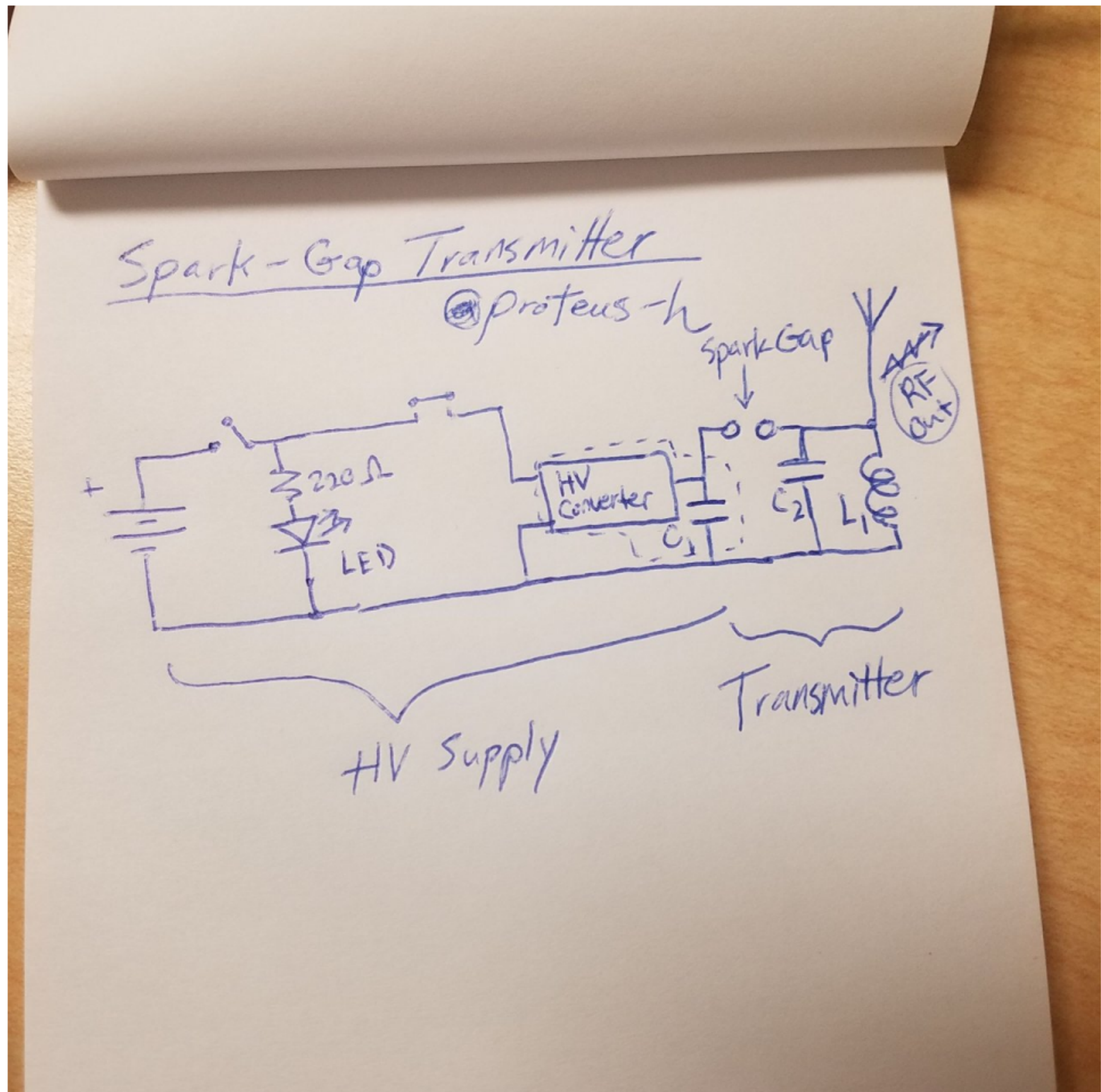
Notably, even without any extra circuitry or wires, the stand-alone stun gun actually jams the AM radio receiver within a few inches of the plasma arc. However, the amount of EM waves produced with just the stun gun is very low and the detectable range is very short. Adding on the extra oscillator circuitry as shown here turns it into a true spark-gap transmitter and massively boosts the range as my tests showed. If you don't have high voltage capacitors for the LC circuit and want to try this, you can also get decent results by just attached a long wire to one of the HV outputs and arcing to the other end, as it serves as a crude antenna.

Note that spark-gap transmitters are very wide-band: They transmit on many nearby frequencies, causing an interference nightmare. A high power spark-gap transmitter would get you in trouble with the FCC. I only

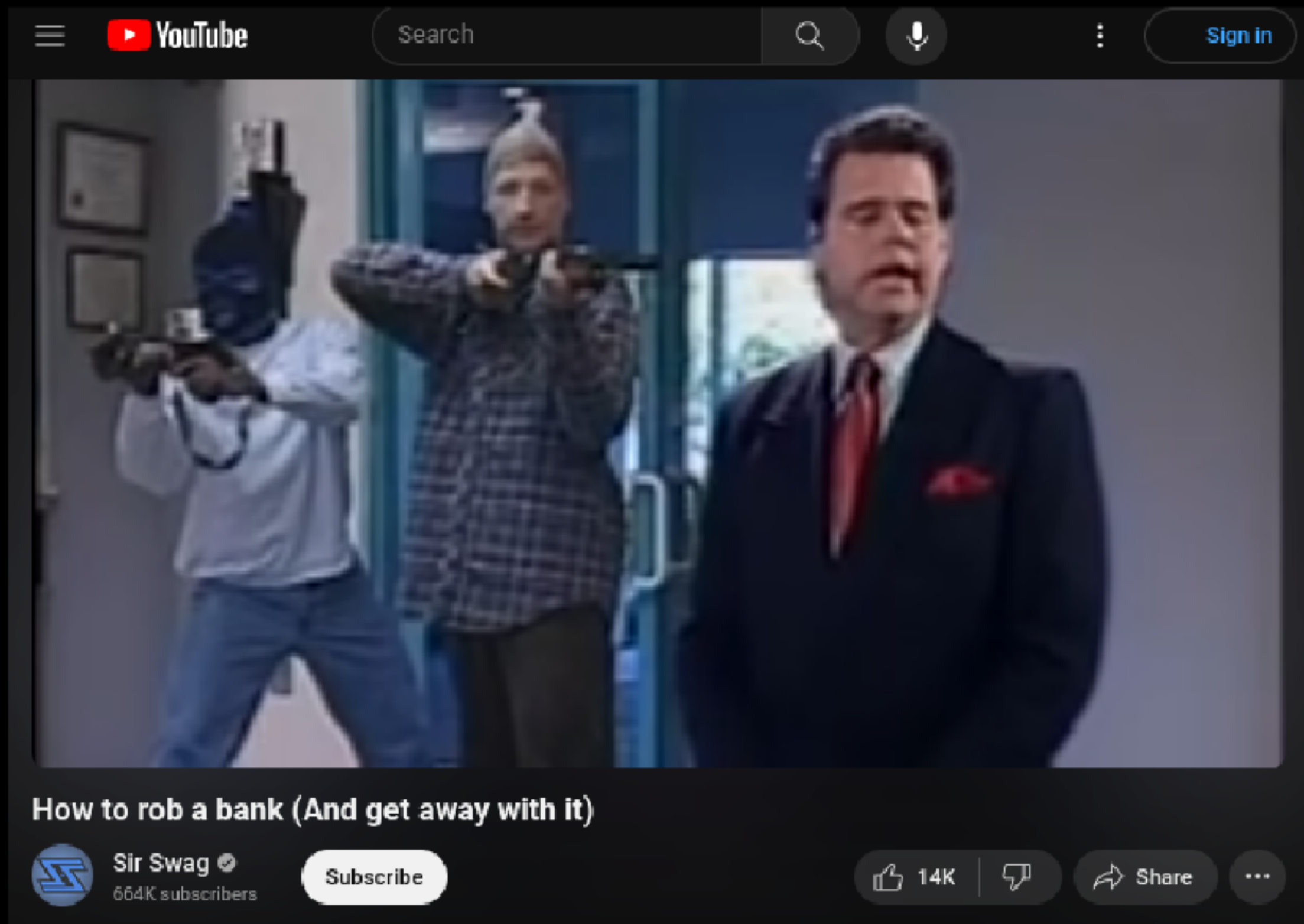
transmitted for short periods of time in my already Faraday-cage like apartment so I doubt I caused any meaningful interference for my neighbors, especially on these low frequencies.

Press the button over and over again on the transmitter and you can send morse code over the air! But don't actually do this at long range, because in the US you'd break a bunch of laws due this being an unlicense wide-band transmitter.

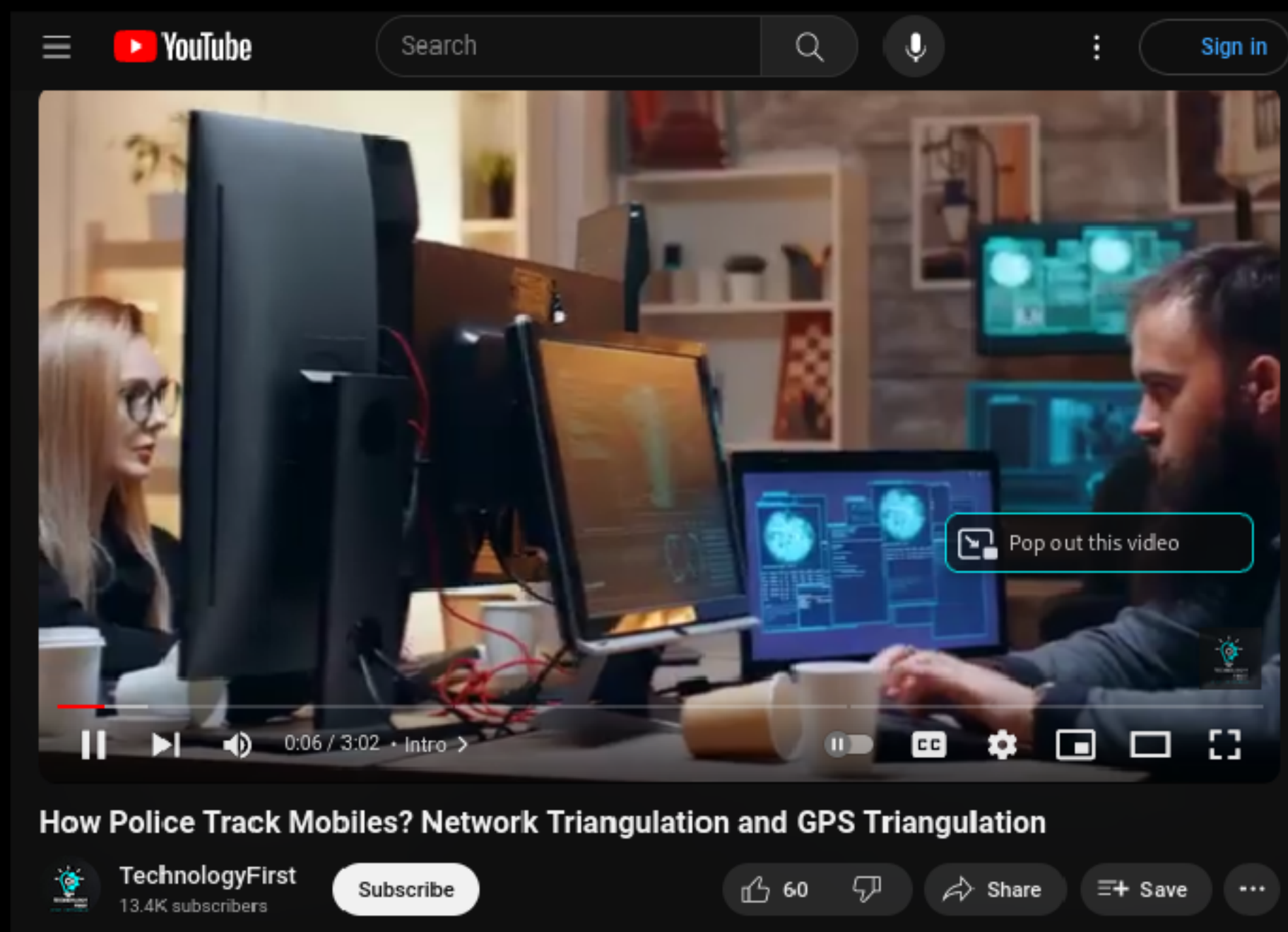
If you're interested in reproducing this circuit for fun, here's the schematic of what I used. The dotted line indicates that everything inside is part of the black HV module.



Schematic of this transmitter. C_1 is the supply HV capacitor and is inside



Watch this video and apply the knowledge and tactics discussed therein.



Watch this video and others like it to understand why having a cellphone or smart watch or bluetooth with you at the power substation or any imminent or future crime scene is a bad idea.

Good luck, niggers, if you choose to read this book and go to an electrical substation.
Be sure to check on OpenInfraMap for targets, but use a VPN like Mullvad or PIA.



You should follow one of two strategies:

Strategy 1 (Careful):

- You all leave your cellphones at home
- You steal a 1970s – 1980s model car.
- You hit the target substation, knocking out the power.
- After hitting the grid, you go to a remote area where a car is waiting.
- Burn the clothes in the trunk of the stolen car and torch the stolen 1970-1980s era car with gas and styrofoam/gas napalm blocks and/or thermite.
- This getaway car must be the car of one of your crew mates.
- The car must not be anywhere near the substation.
- This car of your friend's must have a license plate put on, stolen from a car with an identical make and model. Make sure the tags are not expired.
- You must obey the speed limit and act normal, leaving at night.
- Drop off other friends in a downtown or some parking garage where they will have bikes or buses to catch. Separate. You can not all be in a modern car, on the night of the act, paying a visit to each other crew members home to drop them off as it can be used against you later.
- Do not discuss the act and do not meet up with your cellphones on your person for the next few months, to go dark and wait if it blows over.
- From here, you decide if one was enough or if you want to go to more.
- Repeat the same strategy if you want more.
- Change the barrels, extractors, ejectors and firing pins of your guns and dispose of the old ones if not but really you should do this after every three or four incidents anyways.
- Shred them in a metal shredding machine



Strategy 2 (Dangerous):

- You steal a modern era car the night of the act, effectively carjacking.
- You all go to the substation the stolen car.
- You commit the act and drive to the get away car, presumably an old model 1970s-1980s pickup truck or car with four doors.
- You burn the stolen car at the remote location.
- You drive in your friends vehicle as the getaway and you retain your clothes which you used for the operation.
- You friend the driver, drops you all off. You all keep the clothes and the guns. Change the barrels, extractors, ejectors and firing pins of your guns and dispose of the old ones if you intend to hit another substation.
- Otherwise, dispose of the guns and or parts in a metal shredder, shown above.
- Keep the clothes to burn them in a burn pit at a later date.

Below is additional information you will need. Good luck.





We get it. Your car is your baby. We'll help keep it safe.

Think of us as your OnStar anti-theft team. If someone even tries to break into your car, our Theft Alarm Notification^{[*\(1\)](#)} will let you know your car alarm has gone off.

What if someone steals your car? It's a question we hear a lot — “can OnStar locate my car?” We sure can. Once law enforcement confirms your vehicle has been stolen, our Advisors use GPS to help authorities find your vehicle. But that's just the beginning. When it's safe, we'll work with authorities to remotely slow it down.^{*(2)} And with Remote Ignition Block™,^{*(2)} we can also remotely prevent a thief from restarting your vehicle. If your vehicle is stolen, the OnStar theft protection team has your back. And your car. Our Advisors work with law enforcement to help you get your vehicle back quicker and safer.

Here's how to report a stolen vehicle:

- First, file a police report, and let the police know you have OnStar.
- Then call OnStar at 1.888.4ONSTAR (1.888.466.7827).
- Using Stolen Vehicle Assistance,^{*(2)} we'll help law enforcement recover your car.

Life is unpredictable. It's why we built the Safety & Security Plan.


Life can send us curveballs in all forms. We're here for you. Lost? We've got you. Fender bender? We've got you. Flat tire? We're on it. The OnStar Safety & Security Plan^{*(3)} gives you Turn-By-Turn Navigation^{*(4)}; GM Roadside Assistance^{*(5)} (including towing); and if you're in a crash,^{*(6)} we'll check in and request help, even if you can't ask for it.

[See the Plan](#)

What is the safest way to burn clothes?

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Walt M.
Gainfully Employed · Author has 6.4K answers and 3.2M answer views · Updated 1y

✕


What is the safest way to burn clothes?


Make sure you're not wearing them. That's an important one that some people might forget.


Use a burn pit or barrel, located outside and away from any structures. Also make sure the area surrounding the burn barrel is clear of things that could be ignited by an errant spark and burn uncontrolled, such as dead leaves or dry grass. Don't forget overhanging vegetation.


Prep the area, start the fire, then carefully add the clothes. Never leave the fire unattended. Keep water or fire extinguishers nearby in case the fire gets out of hand, or to extinguish the fire when you're done.


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- Is there a time to throw out or burn clothes instead of wash them?





Deborah Koreneff
Author has 4.5K answers and 4.7M answer views3y


✕

In a metal barrel that has a metal mesh top to keep embers from flying up and starting something else on fire. Keep a hose or fire extinguisher handy for emergencies, and don't walk off and leave it burning unattended. If you are using an accelerant, be careful not to set yourself on fire.

 4







Related questions

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- What happens when you burn clothes?
- Can you burn old clothes in a fire pit or barbeque grill? Can you burn them in your fireplace indoors?
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Amna Mobeen

Knows Turkish · Author has 267 answers and 129.9K answer views · 3y

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When you come to the final item that needs **burning** hold on to it, you will need it for Step Two.


Safety Tips:

1. Always, ALWAYS keep a fire extinguisher on hand.

2. Plan to **burn** your items in a well ventilated area and disconnect all smoke alarms in the room.

3. Use metal tongs to place items in fire.

2



Jim Stephan

Former Soldier (1997–2005) · Author has 669 answers and 2.6M answer views · 3y

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Your neighbors get suspicious.

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[How do I remove burn marks from a cloth?](#)

[How do you dispose of old clothes/shoes/textiles without throwing them in a dumpster or burning them? What's the most environmentally friendly way to get rid of stuff like this?](#)

[Is it legal to burn clothes in the backyard?](#)



Maura Rudd

I care more about comfort and usability than fashion. And it shows! · Author has 19.2K answers a... · 7y

×

Related **Is there a time to throw out or burn clothes instead of wash them?**

Originally Answered: Is there a time to throw or burn clothes instead of wash them?

It is really up to each person, there are no strict guidelines.

If a piece of my clothing starts to look shabby, fabric looks worn, gets baggy or shrinks, or gets a stain I cannot remove, it gets demoted from everyday use.

If it is still comfortable and fits well, I will wear it around the house only. If it is too raggedy to wear even around the house, it gets demoted again and is worn for messy jobs like gardening or painting.

After that is is ready for the trash.


I also donate clothing to charity, but

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 in good condition. I never donate anything that looks too shabb

10

5



John Robinson

Former Firefighter/Paramedic (Retired Chief) (1991–2014) · 3y

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Related **If you had to run through a burning house, how useful is it to soak your clothes in water?**

Interesting question. Much better than "if a car is going 59 mlles an hour for 29 minutes and runs in to a bus full of senators just leaving a party where they ate roasted duck, how far will they travel and how will they vote ne"

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Swedish soldier dominating in



r/ukraine



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personnel mines. Canister ignition above doorway ext.

There is a version effective against armor. But it requires the two aforementioned ingredients + Barium Nitrate. That is the composition used in U.S. Army Thermite grenades (AN-M14 TH3) -- Not as easy to obtain ingredients, and barium nitrate is toxic. The military does NOT let us make this in improvised explosive training, as barium nitrate is toxic and requires proper safety procedures to work with. We did get to see an instructor demonstrate a sample he made though. Does work against armored vehicle plates.

Bottom line. It can be effective in urban environment booby traps. Do not attempt to use against armored vehicles. I can say with absolute certainty as a person who has done that, it doesn't work.



18



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DARKxASSASSIN29 OP • 2 yr. ago

I did mention not to use it on tanks, I recommended it against light armor vehicles. It could probably do a number on tank tracks though. Would take some really good aim though



-4



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kelejavopp-0642 • 2 yr. ago

You know if there's any merit to creating firebombs using liquid styrofoam? I hear packing them into a pressurized tank can setting said tank up to blow can create quite a large amount of fire but it might just be movie stuff.



5



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Hopeful_Tale_1934 • 2 yr. ago

Then, how to hold the bomb? Should the thermite be placed in a container or?



4



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5 more replies



jacspe • 2 yr. ago



r/ukraine



Log In



Youtube channel 'styropro' did an experiment showing this.
Another channel 'beyond the press' also failed to melt through a small steel/concrete safe using about 10kg of the stuff on top.

Also, ignition can be done with a sparkler as a fuse, the type used for firework nights.



3



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DARKxASSASSIN29 OP • 2 yr. ago

Sparklers are made of magnesium (most of them)



1



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jacspe • 2 yr. ago

Yes i know, just thought it would be an alternative ignition method and source of acquisition. Id imagine sparklers MAY be carried by some fancy bars/restaurants for drinks/deserts.



2



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3 more replies



CrikeySimon • 2 yr. ago

Always thought this could be used very effectively against any oligarchs super yachts. They are parked all around Europe if someone is looking to contribute to the cause. A backpack of this stuff would burn through several stories of a Fiberglass hull. Putting a hole all the way though down to the sea. Warning that Fiberglass boats go up very quickly and it may result in the unintended consequences of burning every boat in the marina.



2



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skullrender • 2 yr. ago

Another use for thermite is to put it into the breach or barrels of enemy armour and artillery. You don't need to be able to penetrate the armour to reduce its combat ability to zero



2



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DARKxASSASSIN29 OP • 2 yr. ago

That's a good idea, but it also involves getting uncomfortably close to the enemy tank or artillery position. Its practically a suicide mission.



2



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r/ukraine



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I dread the day when after this war's done, some Islamic fundamentalist nutjob looks through all these reddit posts for ideas.

1

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DARKxASSASSIN29 OP • 2 yr. ago

Honestly, the recipe for thermite is very easy to find, I just thought I would throw it up on here, just in case.

8

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ForwardUntilDust • 2 yr. ago

You really should be unconcerned because the DIY munitions that certain fundamentalists have already crowd engineered and distributed plans for are devilishly innovative.

3d printed pylons and simple actuators so a commercial drone can drop grenades as an example.

Large scale improvised munitions plans using readily available non traceable building materials and household chemicals in proper proportions.

Fuel air or pneumatic grenade launchers.

The list goes on...

2

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Dovaskarr • 2 yr. ago

Tracks and engine bay are targets. Destroyed track is a future destroyed tank in urban enviroment.

1

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DARKxASSASSIN29 OP • 2 yr. ago

This is very true. All they would need to do is stick it on the hull above a track and it will vaporize that section of track

1

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lukethedank13 • 2 yr. ago

I tryed some home made thermite. Magnesium strips are not a sure way to achive ignition. I got better results when i used a mix of sulphur, aluminium powder and potassium nitrate as a primary to ignite the thermite.

Despite what popular media would have you belive it doesnt



r/ukraine



Log In



Destroying captured equipment is where it can be put to a good use. Enough of the mixture will irepairably damage anything you wish destroyed.

1

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